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121

The SCIENCE COUNSELOR

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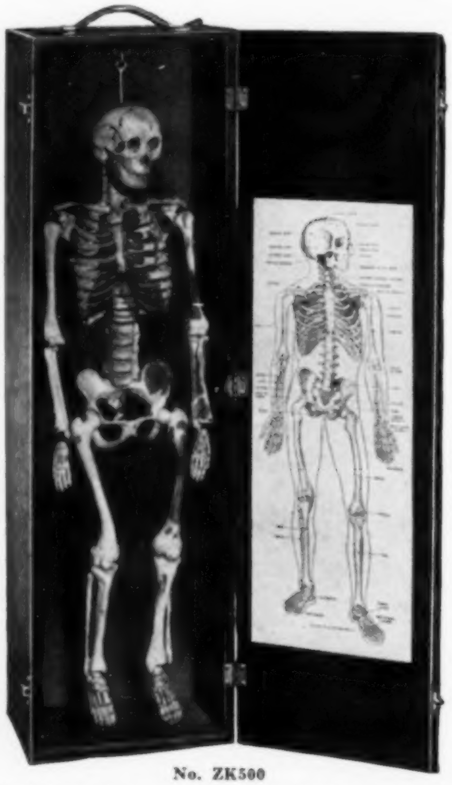

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Mass Spectrometer in Science and Industry

• By Arthur P. Gifford, C.E., *(Rensselaer Polytechnic Institute)*
MANAGER, APPLICATION ENGINEERING, CONSOLIDATED ELECTRODYNAMICS CORP., PASADENA, CALIF.

The mass spectrometer is now being manufactured in quantity as a basic research and analysis instrument for science, medicine and industry. It is characterized by accuracy, speed and versatility. The mass spectrometer is renowned for its use in the original studies of isotopic masses and the relative abundance of isotopes.

This article explains the theory of the operation of the mass spectrometer and some of its newer uses.

Fifteen years ago the mass spectrometer was a scientific curiosity. Today it is a dependable and extremely sensitive analytical tool used in research and industry. Analyses which formerly took days can now be completed in minutes by the use of automatic mass spectrometry and computation. The outstanding advantage of mass spectrometry has been its ability to analyze gases and liquids faster than by any other method.

Mass spectrometers contributed greatly to the emergency development of high-octane aviation gasoline and the synthetic-rubber program in World War II. Today, in addition to being in use in more than 90 percent of the Nation's refineries, mass spectrometers are used in chemical, biological, medical-research, atomic-energy, and industrial process-control fields.

FIGURE I. An analytical mass spectrometer in the research laboratories of Union Oil Company, Brea, California. Two cabinets holding the inlet system are in center, the magnet assembly in the corner, and recording panel at far right. The upper left corner of the panel assembly holds the recording oscillograph.

Operation of the Mass Spectrometer

Operation of a mass spectrometer is made possible because of two principles of physics:

(1) Every substance has a unique arrangement of the atoms within its molecules.

(2) When bombarded by an intense electron beam, the molecules break up in a unique manner.

Separation of the charged molecules or "ions," so they can be individually identified, is achieved electrically by accelerating them into a strong magnetic field. Here the different particles travel distinct curved paths, according to their mass. Any desired group of particles can be made to strike a collector target by correct adjustment of the accelerating voltage, which alters the trajectory.

The collector itself is connected to highly stable amplifying equipment. Amplification raises the minute electrical signals produced by the impinging ions to a level suitable for direct indication of ion abundance on meters and chart recorders.

In graphic form, the relative quantities of the various ions composing a substance constitute its "mass spectrum," an unmistakable, positive means of identification.

The spectra of all pure substances are different. This makes it possible to perform a complex analysis in a short time by algebraically subtracting these constituent spectra from the spectrum of an unidentified mixture.

Commercial Instrument of Recent Origin

Today's mass spectrometer is quite different from the models built by the early experimenters. The early instruments were used to determine isotopic masses and later, relative abundances of those masses. Today's applications are in quantitative analysis, and commercial mass spectrometers are designed for that purpose.

A commercial mass spectrometer suitable for analytical applications was developed by Consolidated Engineering Corporation when the firm became interested in an instrument capable of analyzing the complex hydrocarbon mixtures encountered in the petroleum industry. A mass spectrometer developed at California Institute of Technology was loaned to Consolidated to facilitate preliminary work. After about four years of research by Dr. Harold W. Washburn and his co-workers, a commercial instrument was placed on the market by

Consolidated. The first one was delivered to Atlantic Refining in late 1942.

High Accuracy, Speed, and Wide Range

Used for routine as well as exploratory analyses of mixtures containing as many as several-dozen components, the instrument can detect and measure concentrations as low as 5 parts per million. There is theoretically no limit to the number of mixture constituents which can be identified, as long as the heaviest molecule or ion present can be resolved by the instrument.

Neither physical nor chemical similarity of compounds is of great significance to the mass spectrometer, for it can, with few exceptions, report clearly two or more distinct mass isomers practically indistinguishable by classical chemical and distillation methods.

Second of the mass spectrometer's qualities is speed of operation. Key components are determined in a few

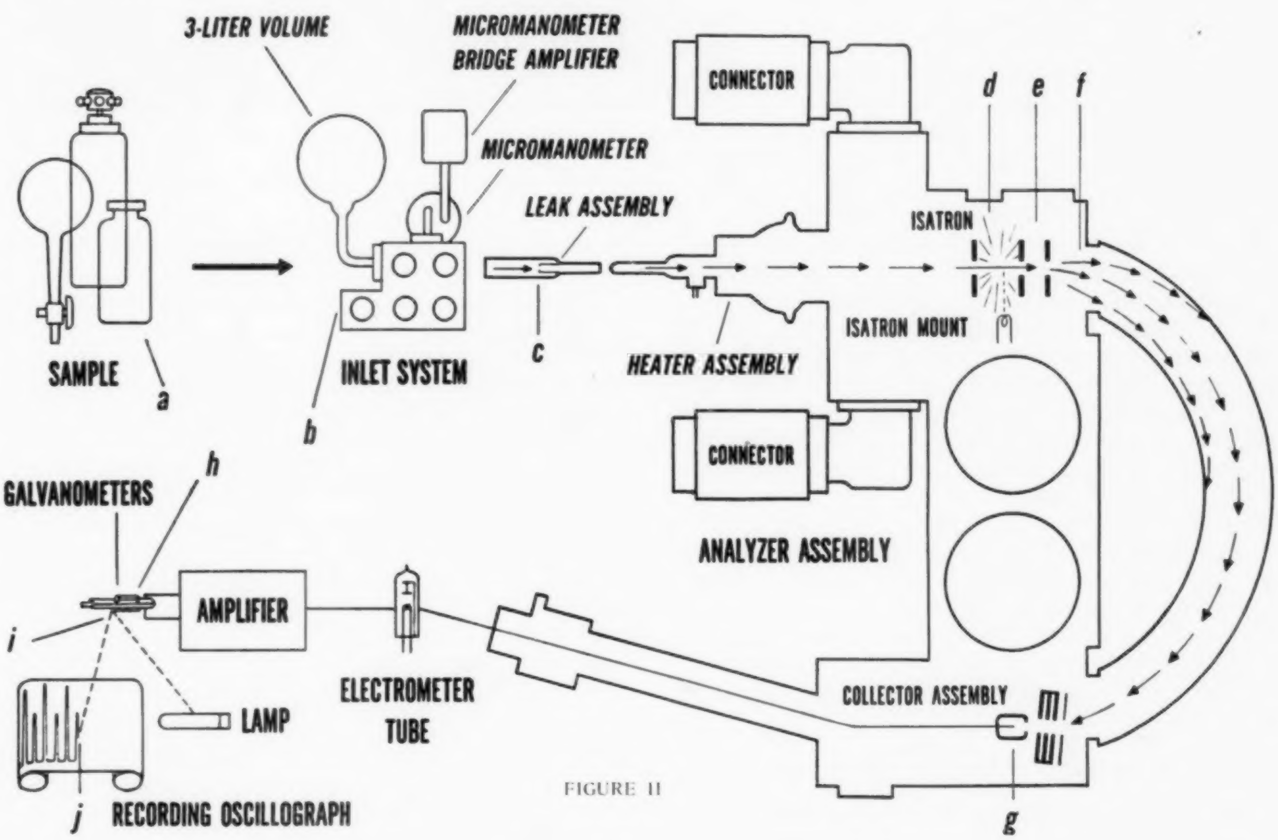

FIGURE 11

HOW THE MASS SPECTROMETER WORKS

a. A sample of the unknown substance is stored in a small container at relatively low pressures, usually in the vapor phase.

b. The molecules are introduced through a series of special valves called the inlet system.

c. The conglomerate mixture of molecules passes through a restriction called a gold leak. The tiny openings allow only a limited number of molecules to pass.

d. In the ionization chamber, called the Isatron, a much higher vacuum is maintained. Here the molecules are bombarded with a stream of electrons from a heated filament. Some become positively charged ions, others are fragmented and positively charged.

e. Ions thus formed leave the Isatron chamber through a narrow slit. They are next accelerated to a high velocity by a strong electrostatic field, and pass through a second slit.

f. A magnetic field, parallel to the slits, diverts the fast-moving ions into circular paths, the radius of which is proportional to the mass and velocity of the ion. Thus, the single beam is split into individual beams.

g. Sorted in this manner, ions of a given mass pass through resolving slits and strike a collector 180° away from their starting point. The charges given up to the collector are amplified by an electrometer tube.

h. Having now been translated into an electric signal, the results are amplified and fed to a bank of five galvanometers, each set for a different sensitivity.

i. A tiny beam of light reflected from each galvanometer mirror is photographed on a moving roll of sensitive paper in the oscillograph.

j. Thus, the complete mass spectrum is obtained, focussing the separated ion beams successively on the collector by varying the ion-accelerating voltage. As each beam sweeps across the collector, its intensity is recorded on the moving paper.

FIGURE III. A portable version of the Consolidated mass spectrometer in use as an anesthesia control instrument during actual operation at the City of Hope medical research center, Duarte, California.

minutes. Complex analyses of mixtures may, with the aid of computing devices, be obtained in an hour or less, depending upon stream composition. In the past, analysis by chemical methods of questionable accuracy often required as much as 24 hours, during which time dangerous and costly process deviations could continue undetected.

Its extremely wide range is a third important attribute of the instrument. Almost all materials are adaptable to its principle of analysis, the only limitation being sample volatility. The substance must enter the instrument in its vapor phase at normal operating temperatures. Present standard instruments accommodate masses as high as 400 without any modification and, with only slight modification, can scan spectra including mass levels as high as 700. Current research is being directed toward increasing the instrument's scope still further.

Completeness of the analysis is a characteristic of mass spectrometer operation that is vital in the face of increasingly rigid product specifications. Every volatile material present in a substance or mixture in a concentration detectable by the instrument being used is registered on the mass spectrum. Such measuring and recording of substances even when they are unexpected makes the method of great value in both quantitative purity determinations and exploratory qualitative work.

The inherent high reproducibility makes feasible the use of libraries of typical mass spectra of compounds for identification of unknowns by a simple process of comparison of their spectra with those already established. A large collection of such known mass spectra is sponsored and published by the American Petroleum Institute.

Major Use Is in Petroleum Refining

Refinery research and production men are enthusiastic about the accomplishments possible with the mass spectrometer. For example, two mass spectrometers are playing a prominent role in both process control and research work at Shell Oil Company's Houston, Tex., process-development laboratory. This laboratory is the central clearing house for 40 pilot plants in the firm's research department.

These plants are all concerned with the improvement of refining techniques through the separation or conversion of crude oil. The mass spectrometer is used to analyze gas samples from the plant streams up to the pentane hydrocarbon range, liquid analyses of hydrocarbons and gasoline fractions up to 400°F, and hydrocarbon "type" analyses.

A mass spectrometer is a basic research tool in the development of petroleum refinery processes by the Universal Oil Products Co. The instrument was installed in the firm's Riverside, Ill. laboratories in 1946. About 600 samples are analyzed each month. Eighty per cent of these are mixtures of petroleum gases containing as many as 19 compounds.

Another mass spectrometer is used at Sinclair Research and Development Laboratories, Harvey, Ill. for rapid examination of gases and highly volatile petroleum products, quickly analyzing mixture samples which would require hours to run by classical distillation methods.

Versatile Instrument Has Many Other Uses

Varied other uses have been found for the mass spectrometer. It may be the key that will make possible design of anti-smog devices for automobiles because it has been found capable of analyzing elusive reactive compounds which up to now have not been identified by usual laboratory means.

A mass spectrometer has been utilized in perfecting the Wulff process for the production of acetylene. This new method uses natural gas, ethane, propane, butane, or any LPG mixture as feed stock to yield a relatively low-cost, but high-purity product.

The most dramatic use of the mass spectrometer is in biological and medical research. It is being used by medical schools, hospitals, and medical research institutions. Its use in studies of a number of diseases at the City of Hope in Duarte, Calif., is typical.

Medical researchers at this non-sectarian national research institute are currently using the instrument in studies of pulmonary ventilation, physiological effects of liquids and solids as an index of pulmonary function, anesthesia control, and genetic studies of cellular metabolism. While most of the City of Hope research is still under way, results are already promising enough to arouse enthusiastic response from the City of Hope scientists for use of the mass spectrometer in medical application.

Until a few years ago, lung surgery was a dangerous undertaking, attempted only in extreme cases because the available knowledge on the lung and its functions

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The Total Experience Science Laboratory

• By Eugene F. Peckman
SENIOR SUPERVISOR, SCIENCE AND MATHEMATICS, PITTSBURGH PUBLIC SCHOOLS

The author, an experienced teacher, has designed a total experience laboratory which provides students with both learning and living experience. If you are planning a new laboratory or if you are trying to make more effective use of the facilities you have, a careful study of this article is a must.

Too many consider education as a means of preparing students to earn a livelihood. They forget that a livelihood is not life but only an instrument of living.

●

The "Total Experience Science Laboratory" is the name used to identify the facilities which provide both an adequate learning experience and a rich living experience. An adequate learning experience consists not only of subject-matter achievement from textbook study, but learning through every other sensory impression as well. It implies not only verbal facility but also knowledge gained through developing powers of observation and impression by seeing, hearing, smelling, tasting, and the kinesthetic, with patterns of response being developed with or without a verbal transition. The living experience is evidenced in the behavior or the personality which grows, with proper attitudes, appreciations, abilities to work independently or to work cooperatively, and with a properly stimulating emotional tone to all activity.

Perhaps a most important educational development in this atomic age has been a greater striving toward learning to live as opposed to merely living and learning. It may be better said that living and learning to live are synonomous in the modern concept of the education of the whole child.

The Problem

Traditionally or unfortunately, subject matter objectives have tended to be the major if not the sole concern of education. The importance of the subject matter in science tends to support the persistence of that attitude. Even subjects with major objectives in the areas of human behavior find it difficult to get out of the textbook and into practice with the patterns they seek. Students in science will have science as their primary, conscious concern; the teacher may share with them only to a limited degree his consciousness of his major responsibility of providing a climate in which may develop certain qualities of behavior. Students in the social studies have a very evident need to understand the physical forces which may change the course of history or affect the behavior of people. These two major areas, of people and of the materials and forces of nature, remain the conjugate foci of all educational effort. They can be best understood only in terms of their relationship, yet each is best approached through its own focus of objectives and experiences.

There are those who will meet our first efforts to improve the living quality with the cynical prediction that it will be all living and little learning. We may be tempted to debate that question versus, all learning and little living. If, however, we may attain some balance, by new enthusiasm, some new facilities, and renewed faith, we may lift both our wings.

As a part of living and learning to live, the necessity for communication goes without saying. Language and mathematics are two sides of the same coin. They too are inseparable—in communication among people or between people and things. Communication among people becomes more important as the need for cooperation increases in modern large scale production and distribution. Communication between people and things is better understood as observation and experiment. The name, Science, has been given to the process of putting questions to nature and discovering the ways in which her secrets are revealed to us.

Teacher-telling vs. Teacher-guidance

In seeking expression of the ultimate goals in facilities for the school science experience of the child, we may fall easily into the common limiting pattern of assigning facilities separately to the two categories of learning and living. If we have failed in our attempt to imply the impossibility of dissociation, let us not fail to mention their unity specifically when space permits. We will have total experience classrooms when facilities are at a minimum; we will have classrooms that never approach the idea, no matter how elaborate the equipment. The life function idea must be a built-in feature of the teacher as well as the classroom.

Let us identify some characteristics of a learning situation of a very low quality. The student sits in the one seat assigned to him for the whole year. He reads a book (the textbook) during that year. He writes textbook answers to textbook questions. He watches the teacher perform the "experiments." He writes mechanically observations obtained by priming and pumping the whole class. He "recites" what he has "learned." He hopes he will remember the exact words of what he has learned until the test. There is little change in the pattern from one day to the next. His few opportunities for expression, to chalk-talk, to demonstrate, to lead discussion, are not sufficient to give him confidence, competence, or the attending motivation.

Let us identify some characteristics of a learning experience of a very high quality, at the risk of being accused of flying too high for this world. The student

sits for a time as part of a group sharing experiences which have to do with the area of science chosen for study. He identifies a problem of particular interest to him out of the discussion, some teacher lecture, or the suggested reading. He seeks information from reading, from observation of related demonstrations, from materials or related equipment at home or in the community, from charts, museum displays, etc. On the basis of all the information he can gather, he makes a scientific guess at the answer to his problem, and formulates possible ways to establish or to disprove it. He moves into the laboratory to put his theory to actual test. He checks his results and seeks ways to improve his performance. He joins a group whose problems seem to be related. They share their findings. They do some additional research in the room library, the school or the central library. They again share their findings. They share the leadership as each demonstrates his leadership in a particular area of activity. He and they explore the relationships of their new (to them) discoveries to other areas of science. Does it affect their own physical well-being? Does it have relationship to other living things? He and they organize to explore the relationship of their problems to everyday health, consumer buying, vocations, recreation conservation of natural resources. They share their findings and look for all possible everyday life applications. He may study the application in a commercial piece of equipment or home appliances. He may build a model of wood, metal or plastic to show how it works. He may make a chart or display and demonstrate it to the class. He may enter it in a science fair, or submit it in a science talent search.

Can he pass a test on the traditional subject content? In his area of special interest he will probably know much more than the teacher, to the great satisfaction of both him and the teacher. In general knowledge acquired in the necessary relationships and background, with his special problem interest and motivation, he will excel his rote-learning contemporary.

A teacher will not be able to do all these things, for all of his pupils, all of the time. But if he does some of these things, for some of his pupils, all of the time, he will be a great teacher.

The course is still determined by the teacher, not by teacher-telling, but by guidance and direction. By creating interest, by motivation, and by releasing the proper reading and working materials at the right time, the direction the student will naturally take in the light of his background and interest, will be the trunk line to whatever objectives the teacher or program of studies have determined as most effectively good for the child and society.

Facilities Are Possible

How can the school provide for all these learning-to-live experiences? Within the science room itself there can be provided an area for lecture and group discussion, an area for teacher and student demonstration, a laboratory area for individual work and for work in varied size groups, a reading and reference area for study and research, special project areas for work with wood or metal or plastics, a display area for charts and three-dimensional materials in coordination, a life or growing area, an electronics area, and others as special interests demand. Again, it may not be possible to have all of these all of the time, but it will be possible to have some of them some of the time.

From the standpoint of learning experiences and subject matter the student will acquire content knowledge; he will have laboratory activity; he will acquire knowledge of science relationships; he will become acquainted with the applications of science to everyday living. It will be a total experience in regard to traditional and modern requirement.

From the standpoint of living experience and personality development, he will have an intellectual experience of far higher quality than the mere acquisition of knowledge, he will have the physical experience of the complete range of sensory impression and muscular coordination, he will have a social experience not only of utmost value to him as an individual but one of critical need in modern society and in vocational and civic responsibility, he should have an emotional experience lending a tone or quality to all other experiences to the point of reaching a spiritual quality. It will be a total experience in regard to his personality development.

The student may relive in the laboratory to a greater degree the total experience of some of the great moments in the history of scientific discovery. It is a different and more impressive experience than that of the vicarious in reading the literature. He may come closer to acquiring some sense of living in its greatest expression, that of living for science that others may live, or that they may live a more abundant life. Pasteur, Reed, Schweitzer, Salk are a few in just one field that he might know by doing a few of the experiments that they have done.

Thus we achieve the elements of a learning experience and a living experience of the highest quality. And the room and the facilities which make them possible will be a Total Experience Science Laboratory.

Some Suggested Solutions

While pointing out the many desirable facilities to provide the ultimate setting for learning and living experiences through science, it will be remembered that in themselves they are no guarantee. But a teacher, who himself, finds every day in his classroom a rich living and learning experience, will make that classroom, with or without the ultimate in facilities, a Total Experience Science Laboratory.

In order that we may conclude with our feet on the ground and assure you that science room planning has progressed to a point where all these facilities are possible, let us present solutions now offered to some of the problems peculiar to secondary school science teaching.

Nationwide studies consistently reveal the following as major factors limiting the effectiveness of secondary school science instruction:

(1) Inadequate room facilities;
(2) Inadequate equipment and supplies;
(3) Large classes;
(4) Difficult schedules with several preparations;
(5) Inadequate allotment of teacher time and energy to the unusually demanding requirements of science teaching.

Despite the difficult conditions under which science teachers presently work, they are constantly urged to develop more scientists and more science minded citizens to save our society and even our civilization. They are asked to operate a modern science program characterized by:

(1) A wide range of learning activities;
(2) Individual and varied group size activities;
(3) Emphasis on the relationships of all the sciences;
(4) Life experience applications;
(5) A variety of methods and procedures.

Modern science room planning recognizes both the present limitations and the ultimate goals. It recognizes that the teacher is the key to any progress in the classroom. How can the teacher be helped to improve his program? How can furniture design and room arrangement eliminate instructional problems at their source—problems of student control; of student traffic friction; of student friction at work stations; of transportation of equipment; of distribution of supplies; of teacher circulation and quick access to every work station; of proper supervision and convenience in giving individual and group help. The increasingly incalculable value of teacher time and energy along with the relatively decreasing cost of mass produced materials makes imperative a new point of view toward such problems.

It would appear that each and every attempt to satisfy the five requirements of a modern science program or to make any progress toward the total experience idea will require more equipment and more materials; and more different kinds of equipment and more different kinds of materials. The teacher has not the ability to manage or the place to store the minimum equipment she now has.

With the total experience laboratory facilities it is possible to have a storage program that satisfies the following conditions:

(1) A specific place for every item.
  (a) Such placement will be possible of inventory record available to teacher, pupils, substitute teacher, or administration.
  (b) Such placement makes the finding and returning of items to their proper place a matter of habit.
  (c) Such placement provides for inventory check at a glance—items are conspicuous by their absence.

(2) The place of storage at the point of use.
  (a) Transportation losses are practically eliminated—time, energy, breakage, distraction of other workers.
  (b) Total responsibility rests with the user—getting out, setting up, returning to storage.

(3) All storage may be under lock and key if desired.
  (a) Teacher control is maintained by long term assignment of student kits to individuals or pairs. Keys are kept in the key cabinet.
  (b) Teacher control is maintained over kits of common use materials by release of the key for the laboratory period only. Keys are identified in the key cabinet by the name of the category or the unit of subject matter.

  The great quantity and variety of materials used in science at a single work station makes impossible equal access to all materials. Priorities in placement are established in relation to frequency of use, possibility of storage in the natural position of use, in safe, in economical, or related in category. Obviously it is impossible to have all the desirable attributes of such a storage plan for each of four or five different students using the same work station in consecutive periods, each with individual assignment, as is common in chemistry. However, by approaching the maximum in community use of equipment, it is possible to attain the maximum degree the advantages of the ideal storage system outlined. It may be possible to have better quality and a greater variety of materials and equipment, in addition to a better solution of the storage problem if more items may be available for common use and less in duplicate for individual assignment.

The type of storage facilities to satisfy the conditions described will require the use of under-table space and adjacent base and wall cabinets. The need for a large floor area devoted to a separate storeroom is eliminated. Under present costs in new construction, this savings in floor area might well cover the cost of the new type furniture and storage installation. Using that floor area to add to the special activity area will multiply the total experience potential of the room many times. The same storage principles for student work stations will apply to the preparation, demonstration, and special life experience activity areas.

Along with more efficient storage planning, new table designs and the new room layouts possible with them, make possible within the same floor area separate areas for lecture-demonstration-discussion and for individual laboratory work. The strait-jacket effect of long rows of tables combining the lecture and laboratory station, now gives way to separate, specifically implemented activity areas, with freedom of movement between them for both students and teacher.

It would also appear that each and every attempt to satisfy the five requirements of a modern science program or make progress toward the total experience idea, will require more and more different kinds of activity all going on at the same time. It is true that this is indeed a radical departure from traditional practice. May we be reminded that education for democratic living requires more than regimenting a bunch of goose-steppers through a prescribed set of routines; that education for more abundant living requires prac-

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Silver Springs . . . And the Balanced Aquarium Controversy

• By Howard T. Odum *and* James R. Johnson, Jr.
DEPARTMENT OF ZOOLOGY, DUKE UNIVERSITY, DURHAM, NORTH CAROLINA

Balanced aquaria are common in school laboratories. Are they really balanced? What systematic studies have been made on such aquaria?

Dr. Odum and Mr. Johnson's article on Silver Springs, a kind of balanced aquarium in nature, and their laboratory study of the balanced aquarium is highly informative.

Perhaps you and your students can undertake a similar project.

Last semester Mr. Johnson was a graduating senior at Duke University.

When J. Leconte was traveling in the south in 1860, his path like that of his famous earlier predecessor, Ponce De Leon, led to some of Florida's giant outflows of clear spring water. He was fascinated with Silver Springs, one of the largest, and wrote a paper in one of the few scientific journals of that day on the peculiar properties of this water in bending light (1861). He also briefly described the lush underwater communities of plants and animals as thick beds of waving grass coated with moss-like plants.

Nearly a century later the water grass *(Sagittaria)* with the mossy encrustrations of algae is still waving in clear gushing waters near Ocala, Florida (Fig. 1). Thousands of people see this entirely natural underwater community each year from glass bottom boats.

FIGURE 1. Underwater view of the waving grass community in Silver Springs, Florida. Miss Ginger Stanley is shown in a record underwater swim down Silver River.
Florida's Silver Springs

Thus it is easy to affirm that the plants, insects, snails, shrimps, and fish in this ecological community eat, grow, are eaten, and die continually in place year after year so that the overall community hardly changes at all. It is a system of nature that has been called a steady state.

The spring with its communities has been called a giant aquarium. What is especially pertinent is that it is a kind of balanced aquarium. Light and the raw materials dissolved in the ground water enter this flowing aquarium whereas heat (from absorbed light), waste products, and excess organic matter flow out as diagrammed in Figure 2. The temperature does not vary more than a degree from year to year or from day to day. The chemical properties of the water even of the natural fertilizer elements like nitrate and phosphate are constant and continually renewed. Thus the spring possesses its own natural chemostat and thermostat. The only main factor that does change daily and seasonally is the sunlight, which of course is greatest in the long days of summer.

It will be recalled that in photosynthesis a group of reactions occur that may be summarized as follows:

$$\text{Light} + \text{Nutrients} + CO_2 + H_2O \longrightarrow \text{organic matter} + O_2 + \text{dispersed heat energy}$$

The respiration of the animals, many of the bacteria, and plants at night may be summarized as the reverse process:

$$\text{organic matter} + O_2 \longrightarrow CO_2 + H_2O + \text{wastes and regenerated nutrients} + \text{dispersed heat energy}$$

The photosynthetic and respiration processes in the natural flowing aquarium, Silver Springs, are readily measured by determining the changes in dissolved oxygen in the water between the springhead and a place ¾ mile downstream (Fig. 2). The water emerging from the ground in the boil (spring head) contains 2.8 parts per million (ppm) dissolved oxygen. This water is not saturated with oxygen since at this temperature (73 degrees Fahrenheit) the water can hold about 8 ppm dissolved oxygen when it is in equilibrium with air. At night by the time the water reaches the downstream station an hour later, the dissolved oxygen content has risen to 3.3 ppm. This rise is due to the diffusion of oxygen into the water from the air which more than counterbalances the nighttime respirations of the plants and animals. In the daytime in addition to diffusion and respiration there is a heavy photosynthesis by the algae and grass which produces organic matter and oxygen as a by product

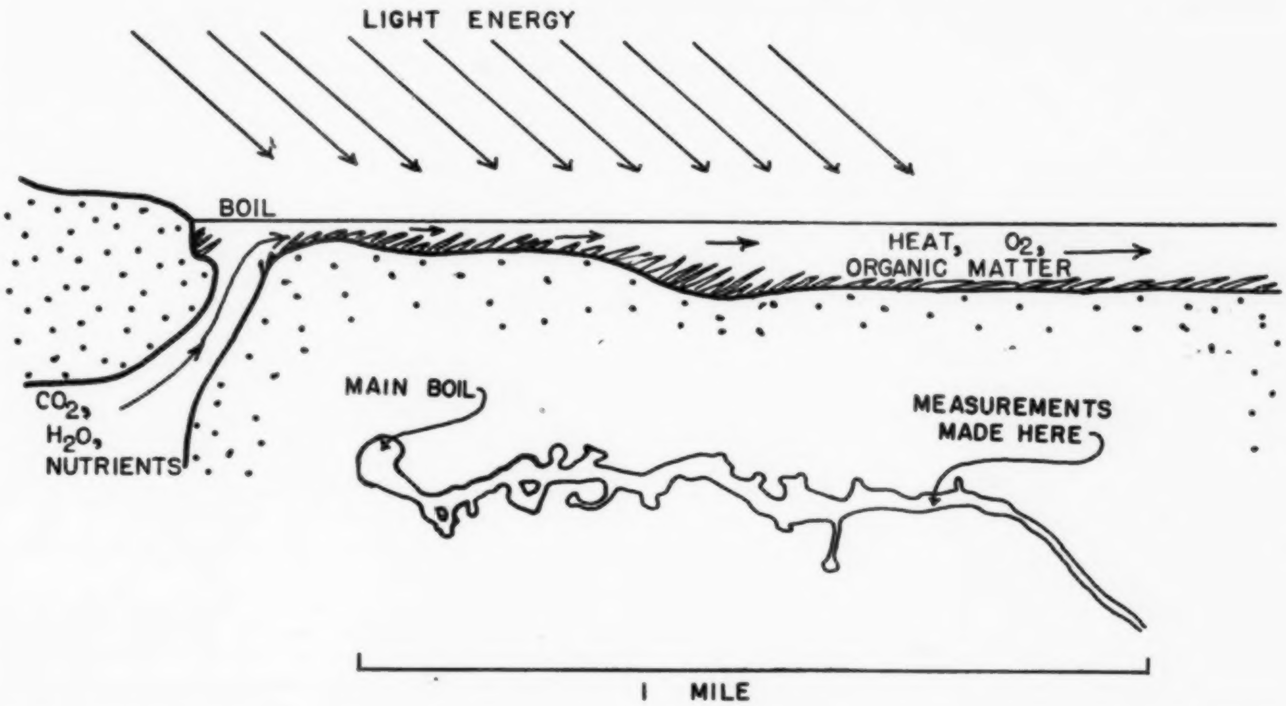

FIGURE 2. Schematic longitudinal section of the headwater area of Silver Springs showing the photosynthetic process which more than balances the respiration of the plants and animals. A map of Silver Springs is included showing the place where measurements of changes downstream were made as illustrated by Figure 3.

as indicated in the equation above. Downstream the oxygen on clear summer days rises to 6.0 ppm. The difference between the downstream oxygen increase at night and that in the daytime is a measure of the amount of photosynthesis. The brighter the sunlight, the greater is the photosynthesis, and the higher is the oxygen downstream. The summer photosynthesis per day is 3 times that in winter. A graph of daily change of oxygen and carbon dioxide at the station downstream during a day and night is given in Figure 3.

The energy of sunlight which is partly stored in the form of organic matter (glucose, proteins, fats, etc.) during photosynthesis as measured by the oxygen production has been roughly accounted for by measuring the organic matter in the water going downstream. About half of the energy is used each night and day by the respiration of the plants and animals. The rest goes downstream as dissolved organic matter, particulate matter, and fragments, which serve to feed communities further downstream. Thus there is a kind of balance although photosynthesis always exceeds respiration within the headwater area. Under these conditions it is found that the ratio of plants to animals is about 15 to 1 (dry weights).

If it is possible for natural ecological communities to become self adjusted into a fairly constant association of organisms is it not possible for the somewhat more closed system, the aquarium, to become self-adjusted? This brings us immediately into the balanced aquarium controversy. In spite of the thousands of aquaria that are kept in schools and homes throughout the world, it is surprising how little in the way of systematic scientific experimentation has been done to see under what if any conditions a balanced aquarium exists. One continually hears of incidental experiments where a community is sealed in a jug and placed in the light with the inhabitants remaining healthy for months, but these interesting projects are rarely published anywhere for others to study and think about. Here is a wonderful opportunity for classrooms at all grade levels. Dr. J. C. Dickinson, Univ. of Florida, Gainesville, for example, describes a closed bottle initially with lake water, which sat in a window and maintained about the same algal population for over ten years. Dr. Larry Whitford, N. C. State College, Raleigh, N. C., tells of a class experiment in which a carboy was sealed, with an aquatic community inside, and kept for a semester.

The status of published knowledge on balancing aquaria has been summarized by James W. Atz (1949). Although his title, "The Balanced Aquarium Myth" and some of his judgments are far too premature, Mr. Atz's main thesis is apparently correct when he indicates that most aquaria as ordinarily set up in homes and classrooms are not balanced. Where he is hasty is in the implication that aquaria cannot be balanced or that if left to themselves will not reach a balance.

For our purposes here we may define a balanced aquarium as being a constant ecological association of plants, animals, and bacteria entirely enclosed in a small container with only the light energy entering through glass and the excess heat being exchanged away through the sides. By this definition the balanced

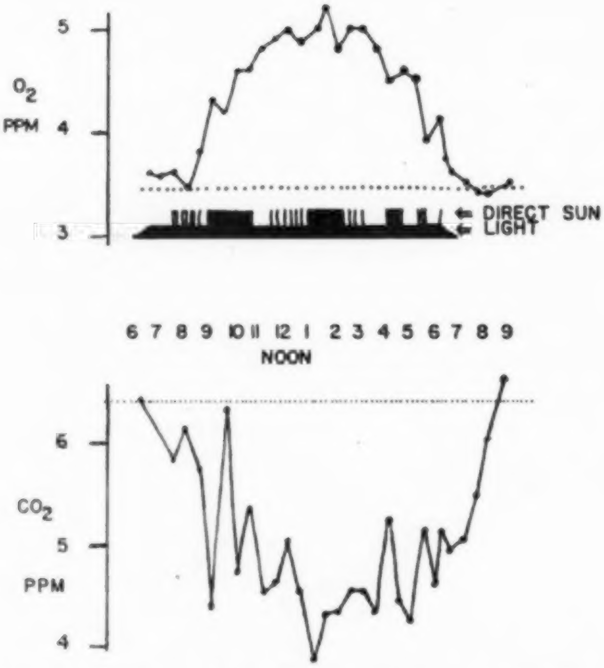

FIGURE 3. Oxygen and Carbon dioxide measurements ¾ mile downstream from the boil in Silver Springs on Feb. 19, 1953.

aquarium is closed with respect to raw materials whereas the Silver Springs community is not closed. For an aquarium microcosm to be constant and thus be in balance it must possess the following characteristics:

(1) There must be a strong enough light so that the resulting photosynthesis will support the animals and plants day and night. Normally less than 1 percent of the light energy gets fixed into organic matter. This is because energy is dispersed as heat for the same reason that no engine is 100% efficient. The nature of energy is such that transfers always result in a dispersion of much of the energy so that it is not available. This is the principle called the Second Law of Thermodynamics. This is why the equations for photosynthesis and respiration given above show dispersed heat as a by product. Most elementary textbooks fail to make this clear in their discussions of these processes. Further information may be found in Odum (1953).

(2) The community must possess a large mass of plants (including algae) to provide food for a smaller mass of animals. This is the general ecological principle that is illustrated by a cow grazing on grass. It takes about 10 pounds of grass to support 1 pound of cow, just as in Silver Springs 15 pounds of plants are required to support 1 pound of animals. Again this principle is partly due to the Second Law of Thermodynamics.

(3) The aquarium must regenerate its own plant nutrients from its wastes such as the fertilizer elements phosphorus and nitrogen.

(4) It must not develop toxic conditions of any kind due to wastes.

(5) It must maintain enough oxygen for the animals and enough carbon dioxide for the plants throughout day and night.

The following is an example of the type of experiment that may give direct information as to the possible workings in aquaria and the nature of self regulatory mechanisms. Six 2½ gallon aquaria were set up with sand, aged aquarium water, *Elodea*, and the snails, *Viviparus*, *Planorbis*, and *Lymnaea*. The plants and animals were weighed (wet) and placed in the aquaria in plant to animal ratios of 100/1, 50/1, 20/1, 10/1, 5/1, and 1/1. First the aquaria were kept, top open, in an ordinary room indoors without any special light for a week. The oxygen in the aquaria dropped in all cases from saturation value of about 8 ppm to about 2.5 ppm indicating that photosynthesis was not balancing the respiration. Thus here the aquaria were behaving like most aquaria as set up for ornamental purposes. This is the type of aquarium discussed by Atz. In such aquaria the following are characteristics:

(1) The light intensity is too small to support the community.

The energy for the community comes primarily from added food rather than from the processes of photosynthesis.

(2) The oxygen is maintained above a lethal level by diffusion in from the air. The accumulation of carbon dioxide is likely to be serious especially if the water is soft and does not have buffer capacity.

(3) With plant photosynthetic metabolism relatively minor, dangers from the accumulation of toxic wastes are great. Thus many aquarists use filters to remove these substances.

(4) The ratio of plants to animals is not pertinent since the animals do not get most of their food from the plants but would have to be fed.

After this period in a low light regime, the aquaria were sealed with vaseline and glass top plates and placed under outdoor light conditions in a greenhouse. The great difference between outdoor light intensities and indoor lighting cannot be overestimated. In the middle of the day outdoor daylight has the order of magnitude of 10,000 ft. candles. Indoor light sources even with fluorescent lights at the top of aquaria may be more of the order of magnitude of 100 ft. candles. Under outdoor light conditions a reasonable community may be supported which cannot exist indoors without special feeding, filter controls, and aeration.

At the end of three weeks of enclosure the contents of the vessels were examined. All aquaria had some new young snails and growing plant tips replacing the dead. The oxygen was slightly supersaturated in all aquaria indicating that photosynthesis has been somewhat in excess of respiration. Since the pH had risen in all aquaria from about 7.6 to 8.5, the carbon-dioxide had thus been lowered so that free carbon-dioxide was not available and the plants present subsequently would have to use carbon-dioxide present as bicarbonate.

By the end of 6 weeks the growing plants by removing carbon-dioxide had raised the pH to 9.6 or above in all aquaria. The water was becoming milky with

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Law Enforcement and the Drugs of Addiction

• By John A. Lieb, M.S., (Duquesne University)
CHIEF CHEMIST, PITTSBURGH AND ALLEGHENY COUNTY CRIME LABORATORY

Modern law enforcement agencies must use every possible weapon in stopping the criminal's war against society. The crime laboratory is a new and important weapon in protecting society.

A new profession, forensic scientist, offers many opportunities to chemists, biologists, physcists and other scientists.

Much of the work of the modern crime laboratory has to do with drugs. Conviction of the seller and user frequently brings on the proof of possession of narcotics. Mr. Lieb describes this phase of the work of the crime laboratory.

Human weakness and the insatiable craving of man for well being lie beneath one of the major law enforcement problems of today much as they have for centuries. Five thousand years before Christ in Mesopotamia, the poppy plant was cultivated for its narcotic juice. The miracles of modern science today provide synthetically a derivative of poppy extract for illicit commerce.

The law enforcement problem in narcotics control is a serious one. Two peculiarities of drug addiction, the intense craving and the unusual phenomenon of tolerance are primarily responsible for the widespread effects of what might otherwise disturb a relatively small percentage of the population. When a combination of desire for narcotics, withdrawal sickness and tolerance to larger and larger doses causes drugs to cost the user fifty dollars a day, he faces the task of acquiring much money. Burdened with the impossibility of obtaining such funds legally, the male addict usually engages in forgery, shop lifting, petty theft, procuration or confidence games while the female resorts to prostitution. This is contrary to the popular idea that the dope addict is a vicious fiend while under the influence of drugs. In reality the drug user is usually relatively passive while under the influence. It is the need for funds which induces much of the criminality of the dope addict.

In a consideration of law enforcement and drug addiction, human habit patterns must be weighed. Tea and coffee habitues develop a conscious longing for that ten and two o'clock coffee break so prevalent among office workers. Cigarette smokers form a habit train that defies many a good resolution. Confirmed or solitary drunks carry often to the grave they dig themselves the failure of will power to overcome the urge for just one more. These habits vary in degree, but are similar in kind. One apparent common point is that the habitue may, with a conscious effort, refrain from indulgence in any of them. If he notices a physical response to the withdrawal at all, it is quite surely an improvement in physical fitness. Herein lies the essential difference between habit and addiction. For the addict it is not solely a question of mind over matter. The alkaloids and other drugs of addiction are characterized by the addict's agonizing physical sickness when the drug is withheld. Morphinists, for example, suffer intense cramps and muscular aches; they perspire and vomit. For them the relief of these physical ills may come about in one of two ways: gradual diminution of physical symptoms over a period of time without narcotics or immediate temporary cure of present symptoms by another injection with, of course, concomitant continuation and increase of addiction.

Why do people fall into such a pattern of life? This is, perhaps, the sociologists' realm, but one fact must be mentioned. The first experiences with a narcotic often produce pleasant sensations which include an exaggerated feeling of well being, withdrawal from reality, and stimulated physiological urges and drives. Continued use of narcotics usually results in a loss of the original pleasurable sensations and the illness attendant with drug withdrawal arises. The amazing tolerance whereby a confirmed addict requires more dope than a fatal dose for a non-addict to curb the withdrawal symptoms completes the cycle which converts the unwary adventurer to the addicted wretch.

Much more difficult to understand than why an individual becomes addicted is the question of why he does not stop. Much has been written concerning means of cure and methods for stamping out dope addiction. The United States Government maintains public health hospitals devoted solely to the cure of addiction. One

Ounce packages of heroin recovered from dope pusher.

is located at Lexington, Kentucky, and the other at Fort Worth, Texas. Do they cure? Emphatically yes, as far as the physiological aspects of addiction are concerned. It might be worthy of note that the physical side of addiction may also be treated by incarceration without gradual diminishing of dosage, brutal though it may be. Seldom, if ever, has an addict been known to expire if the drug is abruptly removed. The reason for the return to addiction seems to hinge on the inability of the rehabilitated to cope with his environment, (perhaps his original incentive) and the salesmanship of the drug peddlers whose income depends on his repeat customers.

Mention of the peddler evokes consideration of a real and underlying evil of the police problem with illicit drug traffic. One may debate the reasons for addiction, but there is no mistaking the dope sellers incentive. The peddling of narcotic drugs is a fantastically profitable illegal enterprise. For example, the small quantity of heroin which profits the smuggler a thousand dollars retails after numerous dilutions and adulterations eventually for probably fifteen thousand dollars. Middlemen and salesmen operate in this business often for the price of their own supply. Customers eagerly await the merchandise. Supply seems seldom to exceed demand. The seriousness of narcotics peddling may be seen from the fact that municipal, county, state, and federal agencies exist for the control of narcotics. The United Nations maintains a Commission on Narcotic Drugs. The State of Pennsylvania has at present a bill introduced before its legislature demanding life imprisonment upon the third conviction for the sale of narcotics. It must be noted that non-addict dope peddlers are criminals whose crimes may not be ascribed to duress, the heat of passion or temporary insanity.

The chemistry of narcotic drugs is largely a chemistry of alkaloids. Those most often encountered in a police laboratory are derivatives of opium, a milky exudate of the unripe capsules of certain species of poppy. About twenty alkaloids constitute twenty-five percent of opium. Of these the most abundant is morphine which occurs to the extent of ten to sixteen percent. Earthy in odor and brown in color, opium has been smoked for centuries by oriental peoples. Its use in the United States is almost negligible, however. It is usually encountered in cities whose Chinatown is extensive. Morphine and its derivatives and salts are the favored fare of American addicts. Morphine and most of its derivatives cause true addiction. Codeine (methylmorphine) occurs as a minor constituent of opium. It is usually not considered seriously addicting, and is much less toxic than morphine. Preparations containing less than one grain of codeine per avoirdupois ounce are classified as exempt by law. Compounds containing less than one-fourth of a grain of morphine per avoirdupois ounce are also exempted. These exemptions permit the sale, without prescription, of paregoric (camphorated tincture of opium) so injudiciously used for teething infants, and certain codeine and terpin hydrate cough elixirs.

Extraction process for the separation of opium derivative from mixture.

Heroin (diacetylmorphine) is undoubtedly the favorite drug of illegal commerce. Once highly regarded in legitimate medicine, it has since 1932 been outlawed by federal regulations banning its manufacture or importation because of its higher potency and increased addicting liabilities. In police practice, heroin is found almost always as a white powder mixture adulterated with lactose (milk sugar) and quinine. Smuggled heroin is approximately sixty-eight percent pure. Heroin recovered by police officers from the addict, after each successive retailer has added lactose to increase his profit, ranges from one and a half to eight percent pure. The quinine has been added to replace the bitterness of heroin lost by reason of dilution for the untrusting addict who tastes his buy to insure against a purchase of pure lactose. Of the other morphine derivatives, Dilaudid (dihydromorphinone) is most frequently encountered.

The tropane alkaloids, derivatives of coca leaves occupy a less favored position in illicit drug commerce. Of these drugs cocaine is the most prominent. Other local anesthetics with narcotic action when administered orally or injected intravenously of this family include such cocaine derivatives or substitutes as alpha and beta eucaine, tetracaine, procaine, dibucaine, and others.

Medicinally not a narcotic, marihuana is, however, prohibited by narcotics regulations. Classified as a euphoriant, its use is said to lead to vicious and heinous crimes. Its violent and unpredictable effect on different people is unusual. For this reason and because it is so often the threshold over which young people pass to the use of opiates, it has been termed a plant which incites to crime and its sale or use is banned. Marihuana (cannabis) is a plant of the hemp family. Other than its use for fiber and its seeds for bird food, there is no commercial or medicinal value attributable to marihuana. The plant is characteristic in appearance in that its leaves are composed of an odd

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Industrial Hygiene -- A Specialty in Integration

• **By Donald M. Ross, M.P.H.,** *(University of Pittsburgh)*
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Industrial hygiene is a complex of sciences: chemistry, biology, physics, sociology and psychology. Its objective is to establish a system of principles for the protection of the health and productivity of the worker.

The author, a specialist in the field of occupational health, outlines the history of industrial hygiene and explains its nature. He discusses the educational requirements of specialists in this new science.

Technological progress has been marked by the development of numerous specialists, individuals who restrict their activities to a particular segment of their parent science. Thus, one less often meets a general chemist, for example, than an analytical chemist, or an organic chemist or more specifically, a rubber chemist, a paint and varnish chemist or a resin chemist. While one cannot deny the necessity for specialization, it is evident that such specialization results in a serious strain on communications not only among chemists but especially between chemists and specialists in physics, engineering or medicine. Further difficulty arises through poor communication in many problems which can be solved only by applying the principles of several disciplines. In industry, the field of industrial hygiene provides a common meeting ground for consideration of many such problems having to do with the health of workers.

A field of specialization which includes both medical and non-medical specialists, industrial hygiene is primarily concerned with the discovery, evaluation, and control of environmental stress as it affects the health and productivity of the worker in industry. The stress may be created by airborne toxic particulates such as the silica-bearing dusts which were the scourge of miners and foundry workers in the early part of this century. Or it may take the form of the excessive heat of a glass factory or steel mill; the high intensity noise of a jet engine testing station; the insidious radiation from the scores of projects employing radioactive sources; vapors from one or more of the thousands of new chemicals produced by industry during the course of a single year; or it may be the more subtle stress of having to work in a poorly designed work area with tools that do not complement the worker's physical capabilities. Regardless of the nature or cause of the stress, all have a common characteristic—they concern man and his working environment and it is this common factor which sustains the field of industrial hygiene.

Interest in the relationship between working environment and health is not new. Indeed, Hippocrates, in the Fourth Century, B.C., was the first to record the adverse effects of environmental exposure to a toxic material, lead dust, among the miners of his time. An Italian doctor, Bernardino Ramazzini, in 1700, published a treatise on occupational diseases in which he described the hazards associated with scores of occupations so accurately that many of them remain useful to this very day. In the 1880's, Lehmann conducted systematic research into the toxic effect of gases on animals which has served as a basis for modern toxic limits.

Despite the rather wide historical background, the practice of industrial hygiene remained somewhat dormant until the twentieth century when, spurred on by the enactment of labor legislation for the protection of industrial employees, the worker's lot assumed a new importance and dignity. It has been an historical observation that where slave labor exists or where labor is considered merely a commodity to be bought or sold, industrial hygiene has failed to flourish. The extension of Workmen's Compensation Acts to include compensation for occupational diseases, in particular, served to emphasize the control of the industrial environment and elevated the specialists in this field to professional status. Following this advancement, the highly competitive insurance companies, who provide industries with the casualty coverage which is required by law, found it was in their best interest to maintain special industrial hygiene services to assist their policy holders in the elimination of environmental health hazards. Finally, following the World Wars, during which maintenance of a high level of health and efficiency was a necessity, industry discovered that a good industrial health department was a financial asset and tended to reduce labor turnover, absenteeism, accidents, and, in fact, promoted good labor relations. What better proof of the efficacy of an industrial health service than the realization that following its installation into an industrial organization, it is rarely withdrawn?

Industrial Hygiene Defined

Let us expand the definition of industrial hygiene in order better to plot its scope. To reiterate, industrial hygiene seeks to identify, measure, and evaluate the stress factors present in the industrial environment, to determine their effects upon the health, well-being and productivity of the worker and, finally, to develop corrective measures for their control. The following implications of this definition are important to the characterization of this field and will bear elaboration:

1. That the stress arises from the work environment. This clearly limits the scope of the industrial hygienist to the working place and divorces him from the myriad of problems which arise elsewhere and have no peculiar relation to the stresses of the industrial environments.

2. That the relationship between the stress and the working environment is well enough understood to be identified and measured quantitatively. Herein lies the greatest opportunity for contribution by the physical scientists: the identification and measurement of these stress relationships. However, this is true only if the physical scientist understands the manner in which this stress affects man.
3. That there is some relationship between the stress and ill health. Clearly the culprit must be labeled before he is controlled. This is not always easy to do, as exemplified by the case of a chemical carcinogen, when the results of the stress may not become evident for several years following the original insult.
4. That there exists some human tolerance level below which the effect is minimal. This is exemplified by the concept of the tolerance dose or MAC (maximum allowable concentration) values for toxic substances. In principle, this concept says that no material is absolutely toxic but, rather, that toxic manifestations appear only when the dosage rate exceeds the ability of the human body to dispose of the material or compensate for it. Acceptance of this concept makes possible the use of toxic materials when properly controlled rather than their complete elimination, which would otherwise be necessary.
5. That there exists a basis for correction of the difficulty. It is in this area that the engineer, enlightened by an appreciation of man's response to stress, makes his greatest contribution.

Thus we see the applied field of industrial hygiene with its base firmly planted in the physical science committed to the thesis that the human response can be translated into physical terms. Although this thesis represents a unique feature of the field and provides the common meeting ground for specialists in the physical, biological and social sciences, it can likewise represent an intellectual block to those entering the field. The physical scientist, accustomed to working in the laboratory where he prides himself on his ability to control all factors in an experiment, is appalled with the variability exhibited by man's response to stress and is reluctant to accept the correlations established between observations on man and the physical measurements of the environment. The biological and social scientist entering the field of industrial hygiene feels completely at ease with the human variability he observes, but is likely to be reluctant to accept the fact that this variability is not meaningless but, rather, exists *about* something and this something can be expressed in physical terms.

The intellectual point of view of the physical scientist is likely to require more drastic adaptation since he must learn to concern himself with man rather than the inanimate objects of his past training. Thus it is that an engineer, using the skills and techniques of his profession, finds he is unable to design an adequate control system for a dusty operation until he understands the nature of the particulate material and under what conditions it is hazardous for men. For example, an engineer who is unaware that lead is absorbed via the respiratory system a hundred times more readily than through the gastro-intestinal tract or that a lead particle of ten microns diameter is too large to reach the deep lung and hence represents no hazard, is not prepared to design a control system for an industrial operation. Similarly, a chemist cannot evaluate the hazard of a dusty operation when he brings to bear on the problem only the refinements of analytical techniques and is not cognizant of the fact that lead present in the air in some forms is hazardous and in others it is not. For example, a one hundred micron lead particle will weigh one million times as much as one which is one micron in size but could not, under any conditions, contribute to the hazard of lead intoxication simply because it cannot reach the seat of absorption in the body—the alveoli of the deep lung. Hence, an analytical method based solely upon weight of lead in the air, no matter how precise it might be, would be worthless in this case in evaluating the lead hazard.

In still another respect must the physical scientist and the medical clinician modify the practices of their professions. Industrial hygiene is concerned with the prevention of the ill effects resulting from environmental stress among *groups* of people and it is only in the behavior of the group that quantitative relationships have meaning in the etiology of occupational disease. This concept of group response to stress is not naturally accepted either by the doctor, who, as a clinician, has been trained to observe individual behavior, or the physical scientist who has developed confidence in the individual, precise measurements of the physical laboratory. Nevertheless, in the recognition of absorption of toxic materials, the first signs are likely to be a significant increase in the excretory level of the material in a group of exposed individuals, an increase which, if found solely in a single case, would of necessity, be regarded as of no significance. Similarly, a scheme has been devised for the detection of man's response to exposure of toxic gases and vapors which utilizes repeated blood pressure determinations on large groups of employees, and here again small changes in the group response herald danger signals which could not possibly be detected in the individual case. By the same token the industrial hygienist must learn to rely upon the results of a long series of air samples taken at various times under known conditions and to be careful of making inferences on the basis of a single sample result. It is in recognition of the importance of evaluating the group response to environmental stress that biostatistics has become such an essential tool in the industrial hygiene field.

There is one concept which so permeates every phase of industrial hygiene that its omission would leave a serious gap in the characterization of this specialty, and that is the idea of teamwork. The essentiality of teamwork can be more fully appreciated when it is emphasized that we are dealing with man-environment relationships and these two components must be studied together. From the time it was realized that the study of the worker alone could not solve industrial disease problems and that information relevant to the nature and behavior of the causative agent was equally essential, teamwork has been the keynote of the profession. By way of example, consider the problem of industrial noise. The measurement of sound energy is clearly a

physical problem but the delineation of the effects of this stress upon the man impinges upon the physiological. One point of view alone will not shed light upon the problem. Similarly, in the case of respiratory physiology, the laws of gas exchange as well as the physiological considerations are important in the study of the uptake of toxic gases arising from gas and vapor exposure.

Educational Requirements

An industrial hygienist utilizes the principles of engineering, chemistry, physiology and medicine in the solution of special health problems in industry. Therefore, it is essential that his broad educational background be in one of these fields.

As a guide for students interested in preparing for a career in this specialty, the committee on Professional Education of the American Public Health Association suggests the following courses as appropriate:

1. B.S. in engineering (chemical engineering has particular value), with electives in physiology.
2. B.S. in chemistry, with a major analytical chemistry and electives in physics and physiology.
3. B.S. in physics, with major studies in electrical measurements and the field of radiant energy, both electromagnetic and vibratory, and electives in chemistry and physiology.
4. B.S. in biological or physiological chemistry, with minor studies in physics.

Having acquired this basic training, however, his education, formal or otherwise, has just begun. Inasmuch as the industrial hygienist will, in all likelihood occupy a staff position in industrial management, it is necessary for him to acquire an understanding of industrial organization and something of the financial and administrative problems with which management is confronted. In addition, his close association with the workers dictates a need for familiarity with federal and state labor legislation and provisions of the workmen's compensation laws.

There exists in the field of industrial hygiene an imposing accumulation of new knowledge and a variety of new techniques developed to meet special requirements. A rather intimate knowledge is required of the toxic nature of the ever growing list of industrial poisons. New techniques will arise for the evaluation of the stress and determination of ill-effects on workers exposed to toxic chemicals, noise, heat, electromagnetic radiation, dust, poor illumination, atmospheric pressure, vibration, monotony of work and many other factors which contribute to illness, reduced efficiency, or a disinclination to work. With the alleviation of many of the more bizarre occupational diseases, human problems arising from the physiological stress of modern industry become relatively more important and will be commanding more of the industrial hygienist's attention in the future. To prepare properly for this eventuality, an understanding of physiological principles as they apply to industry will be of real value.

The broad objectives of an industrial health program are held in common with community health organizations and it is for this reason that the knowledge and practice of the principles and techniques of public health are required.

The foregoing resumé outlines for the Industrial Hygienist an impressive array of special knowledge and training which extends well beyond his undergraduate courses in chemistry, engineering, or medicine. Veteran workers in the field obtained this additional training through practical experience in industry. Today, however, several universities, usually through their schools of public health, have made available a post-graduate course leading to a master's degree in public health. Basically this one-year course covers the fields of (1) epidemiology and biostatistics, (2) industrial and health administration and (3) environmental physiology, industrial toxicology, industrial hygiene, and occupational medicine; and it fits the student for employment in industry, in state or federal public health organization, or in one of the many private organizations which serve industrial health needs.

A final qualification, more a personal than an acquired one, which is a prerequisite to success in the field of industrial hygiene is the ability and the desire to work effectively with other people. The success of his job can easily depend upon his displaying the integrity and sense of responsibility which retains the confidence and respect of the working man while fulfilling a management service.

The Future of Industrial Hygiene

Industrial hygiene, as a recognized specialty, was born and built its reputation in an era when occupational diseases were observed to be a frequent cause of death; when, after working a relatively few years in the mines or granite shops, one expected to pay the price of silicotic disability; and when lead poisoning cases numbered in the thousands. Even with unrefined techniques it was possible for the industrial hygienist to record remarkable achievements and to demonstrate the effectiveness of his work by pointing with pride to the reduction in incidence of industrial diseases. The problems were obvious and his results were obvious. Thus, his activities proved to be self-limiting in that the effect of his success was a diminution of the magnitude of the problems until today an industrial hygienist may work for months or even years without observing a single case of occupational disease. Control programs have been reduced to a routine maintenance basis.

Nevertheless, technological advances have given rise to new types of stresses which may very well lend themselves to systematic analysis despite the fact that they result in no frank discernible disease. A whole series of man-machine problems have arisen whose effects, while not necessarily acute, are more far-reaching than are those resulting from the toxic materials. Noise, once considered an inevitable by-product of modern industry, has proven itself to be potentially damaging, not only upon the individual's hearing mechanism, but upon communication between workers as well. Claims for industrially-caused hearing loss now awaiting court

(Continued on Page 157)

The International Language of Science

• By Alexander Gode, Ph.D., *(Columbia University)*
CHIEF, INTERLINGUA DIVISION OF SCIENCE SERVICE

All, who appreciate the importance of the communication of new scientific findings, should read this article.

Interlingua, a modernized medieval Latin, is used as a secondary editorial language for abstracts and summaries in fifteen medical journals. Science Service publishes a monthly news letter in Interlingua, SCIENTIA INTERNATIONAL.

You will be surprised at the ease with which you can translate the specimen of Interlingua which appears on this page. Try it on your students.

At the Second World Congress of Cardiology in September 1954 in Washington, Drs. Hufnagel, Harvey, Segal, Ari, and Rabil presented a paper entitled "Clinical Evaluation of the First 42 Cases of Severe Aortic Insufficiency, Treated with a Plastic Aortic Valve." Along with more than 300 other papers by other authors, the contribution by Dr. Hufnagel and his colleagues was summarized in the official program of the Congress first in English and then in Interlingua. The title of the Hufnagel paper in Interlingua read, "Evalutation Clinic del Prime 42 Casos de Sever Insufficientia Aortic, Tractate per Medio de un Plastic Valvula Aortic." The opening passage of the summary of this paper read: "Nos ha analysate le casos de quarantaduo patientes con le symptomas classic de sever insufficientia aortic. Lor majoritate esseva masculos con morbo cardiac rheumatic in le secunde o tertie decade . . ."

SPECIMEN DE INTERLINGUA
NUMERO 1

Al laboratorios del statounitese Commandamento de Recerca e Disveloppamento Aeree al Aerobase Wright-Patterson in Ohio, radios gamma ab cobalt-60 es empleate pro indurar nove typos de cauchu synthetic que non esseva vulcanisabile per le methodos conventional. Iste syntheticos, que es nondum revelate al publico, es resistentissime al effectos deteriorante de oleo calide e de extreme frigor. Le processo de induration a radios gamma es efficace etiam pro cauchu natural e quasi omne su surrogatos synthetic. Illo promitte devenir specialmente utile in le vulcanisation de partes constructional de cauchu post lor installation. Le processo esseva disveloppate per W. Jackson (Filio) e Dr. Hale.

Ab *Scientia International,* III,9 (martio 1955)

The large-scale use of Interlingua in the program of the Second World Congress of Cardiology was a pioneering venture. As a result of its success Interlingua is now generally accepted as the most promising device available for the solution of the linguistic problems of international communication in medicine and in science in general. Of the more than 3,000 doctors attending the Congress as representatives of 51 different nations, a little more than 50 per cent spoke English as their native language. Many of the others —though certainly not all—knew English well. But all could read and understand Interlingua . . . all those who felt at home or just reasonably content with the English texts in the program plus all those who would have preferred Spanish or Italian or French or German or even Japanese or Marathi. And this despite the fact that very few, if any, of the cardiologists at the Congress had ever heard of Interlingua before.

Today Interlingua summaries are an established feature of 15 medical journals and at least two scientific news letters use Interlingua exclusively in their columns. In all these cases a single text serves a polyglot congeries of readers who on the whole have not the slightest intention of ever studying Interlingua but who are delighted to see it function because it gives them information that would otherwise be of very difficult access.

The reason for the direct appeal of Interlingua is very plain. In a medical or otherwise technical passage written in Interlingua a great majority of the substantive terms are known to every expert—regardless of his native linguistic background—either directly or by verbal analysis and association with the technical terminology of his professional field. The rest he knows for no particular reason, simply as an educated man; and if there is still a residue of unrecognized words or constructions, they do not impair comprehension or can be guessed at, for the whole of Interlingua contains nothing that runs against the grain of our natural linguistic psychology, nothing that can recommend itself only as an ingenious or logically desirable feature.

It has been said—and correctly so—that Interlingua is eminently suited to serve as the international language of science because it comprises all the traditionally-existing international forms embodied in our scientific terminologies. This amounts to claiming that science has had its special international language all along—though one that was unfit for practical service because it was cut up into individual terms—and that the contribution of the first promoters of Interlingua consisted simply in systematizing the scattered elements of that language and in completing it by drawing freely upon its historical sources.

That science should have at its disposal its own international language seems eminently fitting, for science itself recognizes no national or linguistic limitations. Yet that it is fitting makes the fact neither less astonishing nor less worthy of investigation. In retrospect we should perhaps say that it was of course extremely desirable for science to possess a means of expressing itself in internationally current terms but that the

actual availability of such means was remarkable, not to say miraculous.

Let us illustrate this point by a pair of naive examples. In the English-speaking world we have a strange adverbial concept which the dictionaries define as signifying "with the hand on the hip and the elbow turned outward." When and how this concept crystallized does not matter much. For quite a number of centuries now we have had it and have used for it the word "akimbo" which all other languages had and still have considerable difficulties in translating. This is a monolingual concept designated by a monolingual term. If other nations and other languages felt the concept to be as indispensable as let us say the modern concept of "spectroscopy," they would doubtless manage to find a designation for it, but the process would be arduous and certainly slow. We can watch a phenomenon of this sort for instance in the case of the modern American concept of "human relations" which seems simple enough but which the Germans—who find it useful and who apparently would like to find room for it in their language—have great trouble in naming in an adequate and acceptable way. When on the other hand somebody first coined the term "spectroscopy," the Germans called it "spektroskopie," the French "spectroscopie," the Spaniards "espectroscopia," the Italians "spettroscopia," and so forth.

There are words, it seems, which you cannot create in one language without having simultaneously created their correspondences in a whole string of other languages which you possibly know nothing about. And there are words of a different kind for which all this just is not true.

An example of the first type is the English word "holism," which General Smuts made, simultaneously and unwittingly also creating the German correspondence "holismus," the French form "holisme," and so forth. Back in the eighteenth century a German made the word "statistik," co-creating thereby—without giving the matter any thought—also French "statistique," Spanish and Portugese "estadistica," Italian "statistica," Swedish and Danish "statistik," and so forth. On the other hand, an American made the word "jeep," a restrictedly American word for which no equivalents popped up automatically, as it were, in other languages. When this famous animal had to get a name in German, French, Spanish, etc., the natives tried desperately to supply one and finally had to give up. Now they call it "jeep," a word which everyone recognizes everywhere as American, quite in contrast to "statistics" or "holism" which nobody feels to be either German or South African.

It is simple enough to say that the words of the first group—the one represented by "statistics" and "holism"—are Greek or Latin. Actually this is neither correct nor would it explain much. Where the material that goes into words like "statistics" and "holism" comes from is not as interesting as the fact that this material is simultaneously available in German, French, English, Italian, and quite a number of other languages. It is as though these languages consisted of two layers of verbal material: one exclusive and one shared.

The nature of the exclusive layer of words is the research topic which linguists or philologists have been invented to investigate. The shared layer of words attracts the special interest of the interlinguist.

How far does this partnership of word-sharing extend? It is by nature not at all a universally human affair. It covers the languages of the Western world, the languages of precisely those peoples who depend in their cultural past either directly or indirectly on Rome and Latin, the languages which, roughly speaking, are traditional users of the Latin alphabet. No matter how different these languages may be in one portion of their material, there is another portion in which they are so much alike that they might very well be viewed as dialectal variants of a common norm.

SPECIMEN DE INTERLINGUA NUMERO 2

Le musca drosophila, que pesa circa un milligramma, produce usque a tres centesime calorias per hora. Isto significa que un gramma de iste musca haberea un thermogenese de 30 calorias per hora. Un bacterio in stato de division produce un calor de alicun decenas de milliardesimos de un caloria per hora, sed isto corresponderea a inter 40 e 400 calorias per hora per gramma. In le caso del homine le correspondente valor es solo un a quatro calorias per hora per gramma. Iste mesurationes esseva facite per professor H. Prat del Universitate Montreal per medio de un microcalorimetro, disveloppate per professores Calvet e Tian de Marseille (Francia), que da exacte e continue registrationes con un sensibilitate usque a dece millesime calorias per gramma.

Ab *Scientia International,* III,9 (martio 1955)

One may assert that this common norm of the languages of the Western world is a concept rather than a fact. If so, it certainly is a culturally most significant and potent concept. It is not only a symbolic representation of the cultural homogeneity of the Western world, it also made as indelible a mark on the rest of the world as Western civilization did through the universal impact of its science and its technology. Actually the concept of a common Western language and the dynamics of science and technology belong together. For an Oriental, a native African, or an Eskimo, automobiles, penicillin, syphilis, electricity, and atoms are not American or British or German or French contributions; they are simply Occidental. And the corresponding terms the non-Westerners have taken over for the innumerable items brought to them by Western science and technology are not terms belonging to a specific Western language but simply Western or European or Caucasian terms in a comprehensive sense.

If then the concept of a pan-Occidental language is only in one sense an abstract concept, why should it not be possible to approach it from the side of its concrete reality and raise it to the level of a full-fledged language? Precisely that—not more and not less—was done in the elaboration of Interlingua. That is the reason Interlingua is understood at sight by

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The Southeastern Conference on Biology Teaching

• By John Breukelman, Ph.D.
STATE TEACHERS COLLEGE, EMPORIA, KANSAS

Is the content of your course up-to-date and authentic?

Do you frequently evaluate your teaching methods?

Do you examine the methods used by successful teachers?

Active membership in an organization, such as The National Association of Biology Teachers, will enable you to answer the above questions in the affirmative.

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Ever since its organization in 1938, the National Association of Biology Teachers has fostered the improvement of biology teaching in the high schools and colleges of the nation. Since both high school and college teachers are members and officers of the association, much cooperation and community of interest has been achieved. From the beginning, the association has published *The American Biology Teacher*, which also covers high school and college biology.

Among the salient features of NABT have been its special committees, special issues of the journal, and other special activities. A good example was the three-year National Study-Activity Program of the committee on conservation education, under the direction of Richard L. Weaver, of the University of Michigan, a past president of NABT. This study, which was financed by a $10,000 grant by the American Nature Association, resulted in the publication of a hand book on teaching conservation and resource-use[1].

In May, 1954, the National Science Foundation awarded to NABT a $15,000 grant to finance a ten-day work conference at the University of Florida, just before the 1954 meeting of the American Institute of Biological Sciences, of which NABT is an affiliate. Dr. Weaver, who directed the conservation project, and S. L. Meyer, of Florida State University, were selected as co-directors. Harvey E. Stork, President of NABT, was the chairman of the steering committee for the conference, which was officially named The Southeastern Conference of Biology Teaching.

The conference, which met on the campus of the University of Florida from August 28 to September 6, 1954, had four major objectives:

I. To establish the proper role and major contributions of the fields of morphology, taxonomy, physiology, evolution and paleontology, genetics, ecology, and conservation in the training of biology teachers.

II. To identify and select some of the major problems found in:
   A. the teaching of high school biology,
   B. the teaching of college biology,
   C. establishing a state-wide program of emphasis on biology teaching.

III. To develop suggestions and recommendations for:
   A. the improvement of biology teaching in high school,
   B. the improvement of biology teaching in college with particular reference to teacher training,
   C. greater emphasis on biology teaching, at the state level.

IV. To provide for preparation of state plans for implementation of the recommendations of the Conference, and have a review panel of state department of education representatives to assist in the evaluation of the proposals.

The participants in the conference were selected as state teams, representing Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. Each state team consisted of at least one individual from each of the following categories: scientist, college administrator, science educator, high school teacher, state department official; in addition there were a number of non-regional participants, representing the sponsoring organizations and certain special fields of interest.

In line with the four main objectives, the conference was divided into four parts as follows:

Part I. The subject matter areas of biology.

Part II. The problems of biology teaching.

Part III. Recommendations and suggestions for the solution of problems.

Part IV. Plans for implementation.

The members of the conference were organized into study and discussion groups, each of which included persons from each of the categories. This vertical organization, which brought together into small groups, not only high school and college teachers of biology, but also educators, administrators, and state department officials, was generally agreed to be one of the most effective features of the conference.

In the first two days (Part I) of the conference, each of the six scientists presented his subject matter area to each group. A recorder accompanied each scientist, and at the end of the sixth group discussion, wrote a composite report. These six reports were then presented to the entire conference. The scientists' papers, recorders' reports, and general summary of the subject matter areas in biology are to be found in the published report of the conference. The following is quoted from the general summary of Part I:

> "In general, the conferees were satisfied with the selection and presentation of the six areas. There were several threads of thought which characterized the discussions in all of the committees. Particularly emphasized were: (1) colleges and universities must assume responsibility for in-service

training of teachers of biology in order to build up the breadth of training necessary for teaching or synthesizing topics; (2) special courses in biology and science workshops, requiring no prerequisites and which would receive graduate credit were recommended; (3) the need for integration and synthesis in all courses and programs in biology; (4) at the present, there is a lack of interest in laboratory work especially at the beginning college level. There is a need, therefore, for providing an entirely new, and perhaps unique type of laboratory experience; (5) to impress on all teachers the fact that science is not final nor are so-called authorities final; (6) the need to know why as well as how; (7) an admission that the teachers can be taught; (8) the assumption that the scientific method is not a 'sacred cow.'

"Many contributions have been derived from Section I. Perhaps the greatest possible contribution would come as a result of the adoption of the program of biology discussed and approved by the conferees. With only a few exceptions, however, programs and courses of this type do not exist. Admittedly, courses in general biology, general botany, and general zoology, could utilize and encompass the ideas, ideals, concepts, and principles suggested, but the simple question may be asked—Do they? Not if we insist that the principles and concepts, and their integration, be applied exclusively either to plants or to animals."

Part II of the conference consisted of the identification and selection of problems for study and group discussion. The same group techniques were used as in Part I, the basis of the discussion being the group of papers written in advance by persons who had been selected as members of the conference. The three groups centered their attention on problems pertaining to (A) the public school program, (B) special problems in the training of biology teachers, and (3) the state program in biology.

For section A papers were submitted by: Annie Sue Brown, Science Coordinator, Atlantic City Schools, Atlanta, Georgia; Mrs. Aldina S. Gates, Baton Rouge High School, Baton Rouge, Louisiana; C. R. Hager, Superintendent, Jessamine County, Nicholasville, Kentucky; Mary-Ruby Johns, Biology Teacher, Hillsborough Senior High School, Tampa, Florida; B. L. Ricks, Science Teacher, West Point High School, West Point, Mississippi.

For section B papers were submitted by: Hubert B. Crouch, Professor of Biology, Tennessee State University, Nashville, Tennessee; Ray Derrick, Head, Biology Department, Appalachian State Teachers College, Boone, North Carolina; W. G. Erwin, Biology Department, Northwestern State College, Natchitoches, Louisiana; William Owsley, Professor of Biology, Morehead State College, Morehead, Kentucky; W. W. Wyatt, Associate Professor of Education, University of Tennessee, Knoxville, Tennessee.

For section C papers were submitted by: W. B. Baker, Professor of Biology, Emory University, Georgia; Louise Combs, Director, Division of Teacher Education and Certification, Kentucky State Department of Education; A. B. Cooper, Director, Certification and Teacher Training, Tennessee State Department of Education; Henry A. Shannon, Adviser in Science and Mathematics, North Carolina Department of Public Instruction; G. W. Smith, Supervisor of Instruction, Alabama Department of Education; Percy H. Warren, Dean, Professor of Biology, Madison College, Harrisburg, Virginia.

As a result of group discussion and a general presentation of the entire conference, attention was centered on nine basic problems pertaining to the teaching of high school biology, five pertaining to the preparation of high school biology teachers, and six pertaining to the role of state department in the improvement of high school biology teaching.

The nine problems dealing with the teaching of high school biology were centered on teacher training, objectives of high school biology, integration with other subjects, improvement of instruction, teaching materials, the small high school, in-service aids to teachers, laboratory and teaching space, and evaluation and testing.

The five problems dealing with the teacher training program in colleges were concerned with the college curriculum, working relationships between specialists in biology and professional educators, in-service programs, recruitment, and the improvement of educational philosophy and instruction in college.

The six problems pertaining to the role of the state department dealt with certification, cooperation among various agencies, in-service improvement of teachers, teaching credit for laboratory time, recruitment, selection, and up-grading of teaching practices.

Part III of the conference continued using the group discussion technique. It gave detailed attention to these 20 problems and their possible or practical solutions. Recommendations for the solutions of these problems, make up a large part of the report of the conference.

The recommendations were stated in much detail, covering nearly all phases of biology teaching. Many of the recommendations were familiar, having appeared frequently in papers and talks, and were therefore readily accepted by the whole group. Others, less familiar and sometimes somewhat off the beaten paths of "conventional" biology, led to much discussion, and often rather heated argument.

An example of a readily accepted one was the recommendation that four classes per day instead of five be considered a full teaching load.

An example of a recommendation that made sparks fly was that graduate schools make provision for graduate credit in fields (for example, general botany) which have traditionally been organized for the freshman or sophomore level only, thus giving the in-service teacher an opportunity to take courses he really needs without sacrificing his progress towards an advanced degree.

In general, any virtues the recommendations may have, come not from their originality or cleverness, but from the thorough and many-sided discussion to which they were subjected.

Part IV of the conference consisted of study and discussion of state programs of action for implementing the conclusions and recommendations developed in Parts I to III. Following is a summary of Part IV as re-

ported to the conference and as it appears in the printed report:

"The State teams represented in this conference assumed responsibility and leadership for the following programs of action:

A. Dissemination of information concerning this conference:

1. News release to state and local papers.
2. Summary articles in state education associated journals and papers.
3. Distribution of copies of conference summary report to the following persons and groups:
   a. State Superintendent of Public Instruction and other key personnel in the State Department of Education.
   b. Deans and heads of departments of biological sciences in all institutions of higher learning.
   c. Members of Advisory Committees and Councils on Teacher Education.
   d. Heads of state academies of sciences.
   e. Heads of science section of education associations.
   f. All high school science teachers, college instructors in science, and high school principals.
4. Face-to-face (oral) presentation and discussion of conference report by state team or representatives with the following individuals and/or groups:
   a. State Superintendent of Public Instruction.
   b. Director of Teacher Education and Certification.
   c. Science section of State Education Association fall conferences.
   d. Advisory Committee on Teacher Education.
   e. Organization of School Administrators.
   f. District education conferences.
   g. Home faculty or staff of each conferee.

B. Implementation of Recommendations:

1. Request the State Department of Education to employ or to designate a science consultant to work with college and high school teachers and instructors of science.
2. Encourage college biology teachers to become participating members of the science section of the state education association.
3. Request the director of teacher education and certification in the state department of education to work with teacher education institutions in an effort to get heads of science departments to review and to revise their offerings for a major in biology in light of the proposals made at this conference.
4. Suggest that science staffs of all teacher education institutions attempt to work cooperatively in determining the courses offered for the prospective science teacher.
5. Promote one or two day system-wide workshop for science teachers during the preschool conference period.
6. Determine the true picture of the supply and demand of adequately trained biology teachers in the state to be used on basis for further recruitment.
7. Encourage high school science teachers to organize school science clubs and become members of the junior academies of sciences.
8. Stimulate high school clubs to use lecturers and other services offered by the senior academies.
9. Urge the Councils on Teacher Education and the State Board of Education to adopt the program of teacher education and certification of biology teachers proposed by this conference.
10. Hold a state-wide conference on biology teaching similar in representation, plan of work, and procedures to this Southeastern Conference for the following purposes:
    a. To study the problems in science teaching with particular attention to those of biology teaching.
    b. To initiate publication of a periodical high school science bulletin, and to decide upon types of materials to be included.
    c. To formulate proposals to be made to the Division of Teacher Education and Certification.
    d. To study ways to strengthen teacher education programs in the area of science to the end that a more adequate number of prospective teachers will be attracted to the program and to the end, ultimately, that the quality of science teaching made available to all students will be of such quality and vital enough to make a difference in their lives.
    e. To implement, in general, conclusions and recommendations resulting from this Southeastern Work Conference."

Summary by Louise Combs, State Department of Education, Frankfort, Kentucky.

The report of the conference was published as the January, 1955, issue of *The American Biology Teacher*. A limited supply is still available. Write to the secretary-treasurer, Paul Webster, Bryan City Schools, Bryan, Ohio.

In March 1955, the National Science Foundation awarded to NABT a second $15,000 grant for the purpose of improvement of biology teaching. The 1955 conference, organized along the same general lines as the Southeastern Conference, will take place at Douglas, Lake Michigan, August 19 to 30[2]. The following states will be represented by teams: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Ohio, West Virginia, and Wisconsin. The staff will be as follows: Richard L. Weaver, Director, University of Michigan, P. O. Box 2073, Ann Arbor, Michigan; John Breukelman, Chairman of Steering Committee, Kansas State Teachers College, Emporia, Kansas; Richard R. Armacost, Purdue University, West Lafayette, Indiana; Paul Klinge, Howe High School, Indianapolis, Indiana; Alfred H. Stockard, University of Michigan Biological Station Director, Ann Arbor, Michigan.

Five areas will be explored—plants and man, conservation, human inheritance, health and disease, and food supply of man—under the leadership of well known scientists who will be asked to define the essential subject matter for the preparation of a high school teacher. Closely associated with such definition, and in some cases, a part of it, will be a discussion of the

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There's More to Teaching Aids Than Meets the Eye

• By Alma Deane Fuller

DIRECTOR EDUCATION DIVISION, AMERICAN FOREST PRODUCTS INDUSTRIES, WASHINGTON, D. C.

Teachers are familiar with the effective free teaching-aids supplied by the education departments of many industrial organizations. But do they realize the difficulties encountered in their preparation?

Effective teaching aids result from the close cooperation of teachers with the industrial sponsor. The author, an educational director for the American Forest Products Industries explains the development of teaching aids and indicates the aid which teachers can offer.

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When you pick up a new industry teaching aid, your first thought is probably, "Can I use this?" If it answers an immediate classroom need, you are delighted. If it is not suitable, you may lay it down with a sigh and a wish that someone would prepare free teaching aids which you could use sometime. The point of this article is to tell you that you, as a teacher, have more control over this situation than you may think. Those industries which provide free teaching materials are constantly on the alert to learn what teachers want in the way of classroom materials which it is appropriate for industry to supply.

Most teaching aids go through four stages of preparation and use—planning, production, distribution, and evaluation. Although the industry sponsor carries the responsibility and does the work, teachers can play an important part in three of the four stages. The first is the idea or early planning stage. Suggestions of "Why don't we get out a new booklet on this or a new filmstrip on that?" which have been piling up are reviewed. In making a decision, two major criteria are, "Will teachers use it?" and "Will it carry information which schools lack about our industry?" Ideas which were submitted by teachers naturally carry weight with the sponsor.

Perhaps there are certain hard-to-get facts which you need to round out a unit of study. Or you may have a bright idea for a new way of presenting old but basic ideas—a filmstrip sequence, a wall chart, or a pictograph which would bring the lesson to life in a new way. Or you may have a teaching aid which you think is excellent, except that it was prepared for upper grades and you would like to have a simpler version for lower grade levels.

When selection of the form and content of a new teaching aid has been made, in many instances an advisory group of teachers helps design the first draft. Many industry sponsors avail themselves of this service which is offered through the National Science Teachers Association. Members of this organization may volunteer for such assignments through NSTA headquarters in Washington, D. C. Usually they are reimbursed for any travel or if extensive work is put into preparation of the teaching aid.

Classroom testing is another vital part of the planning stage and industry sponsors are grateful for the cooperation of teachers who will take the time to give a new teaching aid a trial run with their students. The larger the number of classroom tests and the greater the geographical distribution, both urban and rural, the more meaningful the result. It has been a source of real gratification to industry sponsors to receive thank-you letters from teachers who have thoughtfully added, "If I can help you with classroom pre-testing of any of your new materials in the future, please do not hesitate to call on me." Some companies can allow for an item in the budget to cover a certain minimum sampling, but some cannot pay for this service. All are grateful for opportunities to widen the testing and to get the suggestions of more teachers before putting the new item into its final form and into production.

The actual printing or processing of the booklet, film or chart is the only step in which teacher help is not needed. Of course, the sponsor is also chiefly responsible for step three, the mechanics of distributing the new finished product, but here again teachers can play an important role. A sample copy of a new teaching aid may be posted on the bulletin board or passed around at faculty meeting to acquaint other teachers with it. An extra copy might be sent to the professional magazines to which you subscribe for their column listing new classroom materials. Despite the effectiveness of direct mail or paid advertisements, nothing equals the value of "word-of-mouth" promotion, the enthusiastic recommendation of something you have found helpful.

But it is probably in the fourth and last stage, evaluation, that teachers help the sponsor most of all. This is the stage in which sponsors ask themselves, "Is this teaching aid fulfilling its purpose? If not, can it be revised to make it do so?" Companies vary in the degree and method of evaluating their materials but all are constantly employing some criteria which cause them to decide periodically to continue, to revise, or to discontinue each of their school materials. They watch the distribution figures, the number of requests from teachers, specific comments or the lack of comment about the item, how teachers say they are using it. They are especially appreciative of teachers who write, "This is an excellent booklet for fourth grade. It would be even more useful if it were indexed and if new or

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A Report of the Iowa Breakfast Studies

• By Dorothy Greey Van Bortel, Ph.D., *(The University of Chicago)*
NUTRITION DIRECTOR, CEREAL INSTITUTE, INC., CHICAGO, ILLINOIS

A student leaves home after breakfast, spends the morning in class, eats a light lunch and frequently does not eat again until six in the evening. Under such conditions breakfast becomes the meal which sustains him during the active part of his day. What effect does a breakfast deficient in quality or quantity have on his physical and mental efficiency?

Teachers and health authorities continually stress the importance of a good breakfast.

This article is an account of a series of studies on the importance of a good breakfast. College men and women, aged men and boys twelve to fourteen years of age were used as subjects. In all cases it was shown that the good breakfast habit is a sound nutritional principle.

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The Iowa breakfast studies are part of a continuous program of scientific research sponsored by the Cereal Institute, Inc. Leading educational, government, medical and nutrition leaders have stated that from many standpoints breakfast is the most important meal of the day. Yet surveys show that breakfast has become a neglected meal. Thus, the breakfast cereal industry decided to develop and support a research and educational program devoted to the improvement of the breakfast eating habits of America. As a part of that program, carefully controlled studies have been conducted jointly by the Departments of Physiology and Nutrition in the College of Medicine of the State University of Iowa. These studies have been conducted for the past six years and, as of November, 1955, twenty scientific papers have been published.

The research studies have investigated the following areas:

1. The effect of skipping breakfast.
2. The optimum size of breakfast.
3. The relative efficiency of a basic cereal and milk breakfast as compared with a bacon and egg breakfast of the same caloric content.
4. The relative efficiency of breakfasts of animal protein, plant protein or a combination of the two in maintaining the blood sugar above the fasting level.
5. Balance studies for the B vitamins—thiamine and niacin, the minerals—calcium, phosphorus and iron, and for nitrogen.
6. The effect of breakfast on control of body weight.

The subjects used in these studies were young college women and men, aged men, and boys 12 to 14 years of age. To appraise the effect of various breakfast habits upon physiologic responses, specially designed equipment was used to measure choice reaction time (Fig. 1), neuromuscular tremor magnitude (Fig. 2), and maximum work output (Fig. 3). A complete description of these instruments is found in the first article in the series by Tuttle, Wilson, and Daum[1].

From the experiments on college women and men several practical and sound conclusions can be drawn:

Breakfast is essential for maximum efficiency, both physical and mental, during the late morning hours. Skipping breakfast results in decreased work output and mental efficiency.

A basic cereal breakfast, consisting of fruit, cereal, milk, bread and butter, supplying approximately one-fourth of the daily caloric need, was nutritionally a sound breakfast since it maintained certain physiologic functions at peak levels throughout the entire morning. A basic cereal breakfast was just as efficient as a bacon and egg breakfast supplying the same number of calories. A breakfast supplying 25 per cent of the daily caloric need resulted, in most cases in a greater work output than a breakfast supplying 40 per cent of the day's calories.

The consumption of breakfast in which the

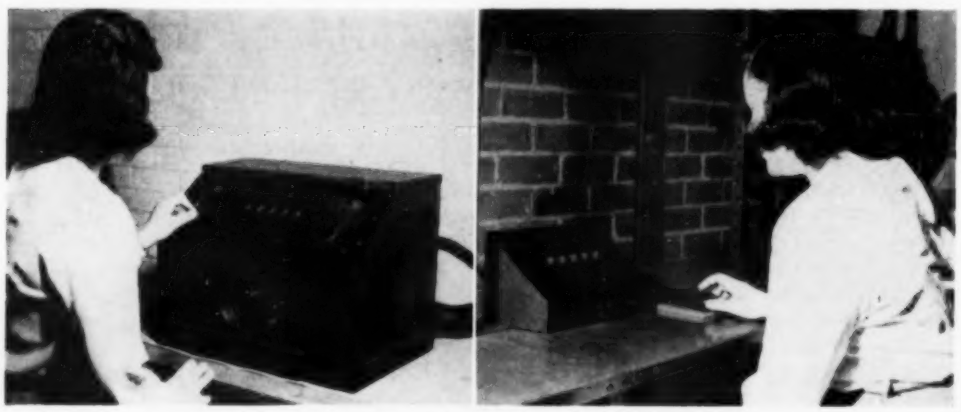

FIGURE I

DETERMINATION OF REACTION TIME—Operator (shown at left) presses switch to flash light before subject in another room. Simultaneously the chronoscope dial hand starts spinning. Dial is calibrated to 1/1000 seconds. Subject (shown at right) has hand on response key which is pressed when light flashes, thus stopping dial hand on chronoscope in other room.

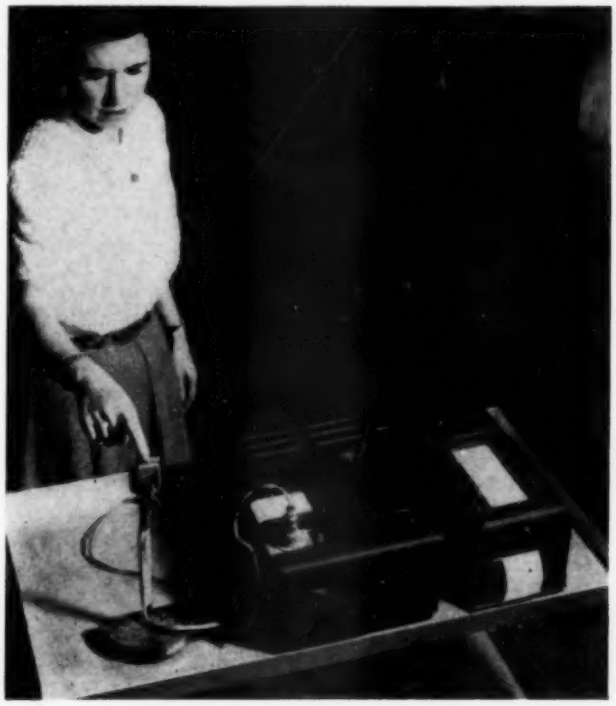

FIGURE 2

DETERMINATION OF NEUROMUSCULAR TREMOR MAGNITUDE. Index finger of unsupported arm lightly touches a pin. Tremor is thus transferred into an electric current which is amplified sufficiently to activate a recording pen. Pen swing and recording paper are standardized.

protein is a combination derived from animal and plant sources is as effective in maintaining the blood sugar above the fasting level as the consumption of a breakfast in which the protein is almost wholly of either plant or animal origin.

From the biochemical studies it was apparent that from a twenty-four hour metabolic performance standpoint, a basic cereal breakfast was nutritionally as favorable as the bacon and egg breakfast providing the same number of calories. From the standpoint of these important B vitamins, essential minerals, and nitrogen balance (which is indicative of protein efficiency), together with the physiologic responses, it was shown that according to biochemical and physiologic criteria, the cereal breakfast was as efficient as a bacon and egg breakfast of the same caloric content.

The subjects (young college women 18 to 25 years of age) showed no significant change in weight whether they had "no breakfast," only black coffee, or ate a breakfast supplying 300, 600, or 1,000 calories along with a free choice of foods and amounts of foods at other meals, so long as their total caloric intake per day was not changed[2].

During 1950 and 1951 a series of carefully controlled studies were made on men past 60 years of age. A summary of the Iowa breakfast studies on men past 60 years of age has been prepared by the Cereal Institute, Inc.[3] In brief, the conclusions drawn from the study of older men not only confirmed many of the findings which applied to the young men and women, but demonstrated that, for the most part, the same nutritional principles apply to the young and old alike. As was the case with the young women and young men, the body weight changes of the older men were not affected by the breakfast regimens.

Effect of Omitting Breakfast on School Age Boys

It has been shown that omission of the morning meal may result in a lowering of the mental and physical efficiency of young women, young men, and old men during the late morning hours. Did these findings apply to boys 12 to 14 years of age?

In addition to the responses measured by the instruments described above (Fig. 1, 2, 3), two additional measurements were used—maximum grip strength and maximum work rate.

The attitudes and scholastic attainments of the boys were deduced from teachers' observations and records.

The experimental procedure was similar to that of the previous investigations. These conclusions can be drawn from the study of 12 to 14 year old boys: Neuromuscular tremor magnitude, choice reaction time, grip strength and grip strength endurance were unaffected by the omission of breakfast. Maximum work rate and maximum work output were significantly less in the late morning hours during the period when breakfast was omitted.

It was the consensus of the school authorities that the omission of breakfast exerted a significant detri-

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FIGURE 3

DETERMINATION OF MAXIMUM WORK OUTPUT. Subject is shown riding a bicycle ergometer at maximum effort for one minute. Electric current thus generated, recorded as volts, is changed to work equivalent by the use of a calibration table.

Teaching Science by Television

• By John C. Schwarzwalder, Ed.D., *(University of Houston)*
MANAGER, KUHT (TV), HOUSTON, TEXAS

How does teaching by television compare with conventional teaching?

Doctor Roney of the University of Houston has taught the same biology course to one group of students by television and to another group in the conventional manner. The number of students in both groups was large enough to provide reliable data to evaluate the program.

Doctor Schwarzwalder is Chairman of the Department of Radio and Television at the University of Houston.

The University of Houston has completed two years of experimentation in teaching Biology, a required course in certain areas, by television. The experiment was carried on over KUHT (TV), the first educational station in the nation, which is owned and operated by the University of Houston.

The courses taught were Biology 131 and 132 which are "General Education" science courses on the freshman level. Methods used include lecture, demonstration and discussion. No laboratory hours are required. One-half of the three hours' attendance required of the student was spent in small seminars on the campus. The other hour and one-half the student watched the instructor on television. There were two forty-five minute lectures each week. The great majority of the students watched the lectures at home. A few watched them from sets located on the campus. The television lectures were given from 7:00 to 7:45 p.m. Monday and Wednesday evenings. They were repeated on television from 7:30 to 8:15 a.m. on Tuesday and Thursday mornings. This last was necessitated because a number of students worked during the evening hours and could not view the lectures at those times.

DR. H. BURR RONEY, Associate Professor of Biology, University of Houston. Teaching Biology by television over KUHT (TV).

Conventional classes in the same course were offered for those students who could not arrange schedules to see the TV lectures. During the Fall Semester of 1954-55 some 453 students followed the lectures by television while 243 were taught in the conventional manner. During the Spring Semester the ratio was 325 by television to 235 in the classroom sections. There was considerable interchange between semesters, many students in the classroom sections moving into the television sections for the second semester and vice versa.

Student preferences, as reflected in various questionnaires, showed that a small group preferred classroom instruction and that an equally small group preferred television instruction. The great majority of the students, however, made the choice between television and the classroom solely on the ground of convenience in making out their individual schedules.

An elaborate study[1] of the effectiveness of the two methods of teaching these courses was made with results as follows: there was no statistically significant difference between what was learned by the "television students" and what was learned by the "non-television students." These results, of course, are typical of results in a very large number of studies concerning television courses in other areas, but the numbers involved in other studies done by colleges and universities have seldom been as large.

The courses were all taught by Dr. H. Burr Roney, Associate Professor of Biology at the University of Houston. Dr. Roney, an experienced teacher, had not previously taught by television but was interested in experimenting with the medium. He states that on TV the instructor's sense of the clarity and effectiveness of what he is doing more than compensates for the absence of a group of students in front of him. He feels that television is especially good for a course in Biology because the camera can pin-point small objects far better than this can be done in the classroom.

Dr. Roney has stated that the preparation of a television lecture is more work than is usually put into preparation for a classroom lecture but not more than *ought* to be put into classroom lecture preparation. He retains

[1] An Evaluation of the Effectiveness of Instruction and Audience Reaction of Programming on An Educational Television Station. Evans, R. I. and H. Burr Roney, and W. J. McAdams. Published by the Journal of Applied Psychology, Aug., 1955.

his enthusiasm for teaching by television and will continue to teach the Biology courses by television in 1955-56.

From an administrative standpoint successful teaching of science courses by television is also attractive. It saves a great deal of room space at peak hours. In this instance, at the University of Houston, it can be shown that, assuming a forty-seat classroom, at least eleven classrooms were saved for one and one-half hours a week or for a total of 16½ classroom hours per week. Moreover, for this large a group at least eleven sections would be required which would necessitate at least two additional instructors. The savings realized from both these aspects of television teaching are considerable, though they will vary from one college to another. Obviously the college with more room space than it needs will not be as interested in television teaching as the one which has problems of space for classes.

One further advantage of television teaching is that it is possible to standardize teaching at the highest level. Few indeed are the institutions which have a plethora of able scientists, who are also excellent teachers, on their staffs. By means of television, however, one able teacher can reach literally thousands of students with his lectures. This is an advantage which can not be shrugged off lightly.

The conclusions we have reached as a result of this experience in teaching science by television may be summarized briefly.

First, there are definite advantages to teaching science in this way. There are financial advantages, space-saving advantages and educational advantages.

Secondly, we are now sure that the project is educationally sound. We intend to continue along this line. ●

★ ★ ★ ★ ★

Teaching Aids

(Continued from Page 141)

difficult words were explained in a glossary instead of in the text." There may have been compelling reasons why an index or glossary was not included at the time of publication, but the suggestion will be reconsidered in evaluating the effectiveness of the book and in planning its future. Some suggestions, though pertinent, may have to be passed over for budgetary reasons. Others because differing opinions may have been received from other educators. Nevertheless, all suggestions are welcomed by the sponsor, to the end that teaching aids may more nearly fulfill their purpose of helping the teacher to do a more effective job. ●

Mass Spectrometer

(Continued from Page 124)

was extremely meager. Then it was discovered that man has more lung capacity than he needs, and certain surgery can be accomplished without fear of disastrous consequences. But since individual lungs vary, the question is—how much lung capacity does a particular person need? Although individual differences in lung size have no significance, the *efficiency* of the lung is of prime importance.

Pulmonary ventilation is important as an indication of lung efficiency—and is related to pulmonary circulation for low levels of concentration of gases in the lung. One research group is measuring the ventilation of the lungs and the elimination of various gases through the lungs by means of CEC's mass spectrometer. The group is convinced that a continuous-analysis, high-sensitivity mass spectrometer provides a clinical tool for the rapid diagnosis of pulmonary disorders. Such direct, immediate, and accurate diagnosis has never before been available in a single instrument.

Working toward the same end, but by a different method, the research group is studying the physiological effects of liquids and solids as an index of pulmonary functions. One material especially well suited for this study is alcohol. When alcohol is introduced directly into the blood stream, it combines with the blood in much the same manner as oxygen, and is exhaled from the lungs. Alcohol is unusual from another aspect—since it is a pure carbohydrate, it will produce an "exact" metabolism; i.e., in the normal human being it is always broken down by the body processes into an exact ratio of the same constituents. Patients with cancer for example, assimilate carbohydrates differently. The mass spectrometer is used to measure the relative proportion of CO_2 and H_2O and alcohol in the exhaled air. The difference in these proportions distinguishes between normal and carcinogenic patients.

The mass spectrometer is being used to determine lung efficiency of emphysema patients prior to operation. In this disease, sacs appear in the lung which are merely "dead space" and contiribute nothing to the function of the organ. It is imperative that, before operating, a measure of lung efficiency be obtained to make sure that the portion of the lung remaining is sufficient to carry on the breathing process. The use of the alcohol technique described above is effective because the thickening of the alveoli (air cells where oxygen is transferred to the blood) in these cases makes breathing difficult, and precludes the use of a gas in the efficiency determination.

Still another study is being conducted on anesthetics. Anesthetics usually regulate the supply of gases by the physical appearance of the patient. This, of course, is a practical but not entirely accurate method. By the time cyanosis (turning blue) is apparent, some physical damage may have occurred. The mass spectrometer can be moved directly into the operating room where the anesthetist can determine at all times whether CO_2 or the common anesthetics (ether, cyclopentane, nitrous oxide) have reached dangerous levels in the lungs.

Future of Mass Spectrometer Largely Untapped

Much research remains to be done to exploit the full potential of the instrument. It has tremendous possibilities in medical research. Similarly, petroleum and chemical engineers feel that there are many things yet to be accomplished with it, particularly in its growing use as a process and monitoring control instrument. Direct process monitoring with the mass spectrometer is a reality today. The so-called "closed-loop" control, in which the instrument not only measures and indicates, but also automatically sets in motion corrective methods should the product under surveillance wander from the desired composition, is the next step forward. ●

★ ★ ★ ★ ★

"The ultimate end of created nature is the glory of God, and men of science, as authorized interpreters of nature, are exhorted by Pius XII to acquaint their fellowmen with the marvels abounding in the universe. Since the majority of men are limited to gaining a superficial impression of the world about them, it becomes the office and the dignity of scientists to make known to others the beauty, the perfection and power of creation. In this way men may be brought to admire the sublime splendors of this world and thus to adore their Creator, to praise Him and to thank Him."

—VERY REV. AIDEN M. CARR, O.F.M., CONV. in *The Homiletic and Pastoral Review.* (Sept. 1955)

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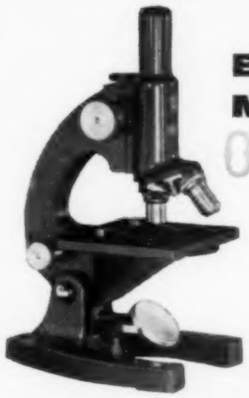

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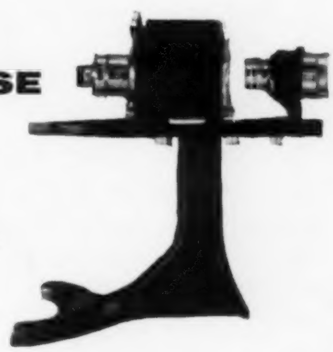

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Law Enforcement and Drugs

(Continued from Page 132)

number of long narrow leaflets with serrated edges. Seven leaflets usually comprise a leaf, although poorly developed leaves or those near the plant's top may have only five. The plant is indigenous to temperate regions where it varies from three to sixteen feet in height. The leaves, flowering tops, stems and seeds are crushed into a tobacco texture mixture and smoked in hand rolled cigarettes. As previously noted, it is not classified as a true narcotic. Withdrawal sickness and tolerance are not associated with its use.

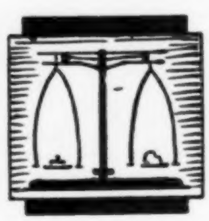
Of the recent synthetic drugs which have been classified, amidone, keto-bemidone, and Demerol are included in those regulated by narcotics regulations. Their action and addiction sustaining liability seem comparable in nature and kind to those of the opium narcotics.

Concerning the methods of dosage of the common narcotics, the "modus operandi" of the true addict seems not to vary from one city to another. Powdered narcotics are dissolved in water heated in the ladle of a spoon or bottle cap. The use of a match or cigarette lighter for heat source leads to a blackening of the utensil. A small wad of cotton is invariably added to the water solution. It has been said that the superstition exists among addicts the world over that the cotton sterilizes the mixture. It more probably is added to serve as a filter through which the solution is drawn into a medicine dropper equipped with a hypodermic needle. Opiates, tropanes, and synthetics are injected into a vein usually in the inner forearm in the most unsanitary operation imaginable.

Admittedly a much broader issue in law enforcement than it has been possible to discuss here, the age old problem of narcotics addiction must be of interest especially to those responsible for the education of young people. A stringent vigilance for the insidious entry of dope into the lives of adolescents is essential and might include a knowledge on the part of teachers and parents of those "trademarks" of addiction which include the possession of hypodermic needles, medicine droppers, blackened spoons or bottle caps, and the presence, especially on the inner forearm, of puncture or needle wounds. As an adjunct of possible value an incomplete but representative glossary of some of the common terms of the colorful and unusual jargon of the "dope" trade is included below:

charley—cocaine
coke—cocaine
deck—a small packet of morphine, cocaine, or heroin
dope—drugs
fix—a drug shot
H—heroin
Harry—heroin
Hazel—heroin
horse—heroin
hophead—narcotic addict
hypo—hypodermic needle
jolt—an injection of a narcotic drug
junk—drugs
junkey—drug addict
loco weed—marihuana
main liner—one who injects a drug—usually in the forearm
piece—an ounce of morphine, heroin, or cocaine
pop—a drug injection
pusher—retailer of drugs to addicts
reefer—marihuana cigarette
runner—teenage contact used to recruit new addicts
shot—a drug injection
snow—cocaine
stick—a marihuana cigarette
weed—marihuana

When interested and informed citizenry curtails by supervision of youth the possible future market potential, alert and conscientious law enforcement eliminates the source of narcotics supply, and psychiatrists and psychologists rehabilitate the currently addicted, it is probable that the narcotics problem may be relegated to a position of importance only to the future historian. ●



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International Language

(Continued from Page 137)

every Occidental, regardless of what his regional mother tongue may be, provided he is educated on a level of what we might call pan-Occidental sophistication, and also by every non-Occidental, provided he is actively engaged in the maze of things and thoughts and terms which the West has carried to the four corners of the world in the wake of its scientific and technological advance.

Interlingua has been called Standard Western European. That is all right. It has been called modern Latin. That is all right too. The name as such does not matter. The important thing is that the language can be of service in international communication, on a pan-Occidental plane without restriction and on a universal plane at least in the realms of science and technology, and that it can do so immediately without having to wait until its advocates and its students circle the globe.

But there is one aspect of this entire matter that I must at least touch upon by way of conclusion and by way of invitation to further serious thought. As things now stand, Interlingua is primarily a tool in science communication. It is being promoted not as a "universal language" in any vaguely idealistic sense of the term but simply as a device of perhaps restricted but certainly definite usefulness in technical summaries, congress programs, and the like. Yet its very existence and certainly its efficacy are conditioned by the oft-forgotten fact that the Western world is a cultural entity. As a linguistic reality Interlingua serves science and reflects the identity of the Judæo-Christian Greco-Roman tradition. The roots of science are more deeply embedded in that tradition than our colleagues in the humanities are apt to concede. Scratch a scientist (a real one), and what do you find? A humanist of course. Scratch a humanist . . . But that is a thing I would never dare do. ●

How Did You Translate the Specimens of INTERLINGUA?

SPECIMEN OF INTERLINGUA NUMBER 1. At the laboratories of the U. S. Air Research and Development Command at the Wright-Patterson Air Base in Ohio, gamma rays from cobalt-60 are used to harden new types of synthetic rubber which could not be vulcanized by conventional methods. These synthetics, which have not yet been released to the public, are very resistent to the destructive e.fects of hot oil and extreme cold. The hardening process by gamma rays is also effective for natural rubber and almost all its synthetic substitutes. It promises to become especially useful in the vulcanization of rubber parts after their installation. The process was developed by W. Jackson, Jr., and Dr. Hale.

From *Scientia International*, III,9 (March, 1955)

SPECIMEN OF INTERLINGUA NUMBER 2. The common fruit fly, which weighs about one milligram, produces up to three hundredths of a calory per hour. This means that one gram of this fly would have a heat production of 30 calories per hour. A bacterium in the state of division produces a heat of some tens of billionths of a calory per hour, but this would correspond to 40 to 400 calories per gram per hour. In the case of man, the corresponding value is only one to four calories per gram per hour. These measurements were done by Professor H. Prat of the University of Montreal by means of a microcalorimeter, developed by Professors Calvet and Tian of Marseilles, France, which gives exact and continuous recordings with a sensitivity of up to ten thousandths of a calory per gram.

From *Scientia International*, III,9 (March, 1955)

New Books

Discovering Buried Worlds

• *By* ANDRE PARROT. (Translated from the French by Edwin Hudson.) New York: The Philosophical Library, Inc. 1955. Pp. 128. $3.75.

By the instruments of the archaeologist, the whole panorama of civilization has been brought to light in the last hundred years; in so many pages, Andre Parrot brings it from the fields of technical archaeology to the light of the reading public.

Too often we think of archaeology as filling in small spaces on the historical map. This author demonstrates the fact that until the Nineteenth Century—with the rehabilitation of Assyria, Babylon and Mesopotamia—that map was almost a complete blank. Not only has the blank been filled in, but with every new decade of archaeological discovery, it assumes larger and larger dimensions. Even in the last ten years, four stages—Hassuna, Samarra, Halaf, Eridu—have been passed through, filled in, defined.

The casual reader need not be frightened by these names, nor should he think that this is a book of dry formidable erudition. It is the kind that lures the uninitiated on and on. It has wit and humor, none of which suffered in the transit from one language to another in the hands of Edwin Hudson. For the specialists, there are six pages of bibliography. Best of all, the work has a copious supply of beautiful illustrations.

Herman F. Flynn, C.S.Sp.
Duquesne University

The Gifted Student as Future Scientist

• *By* PAUL F. BRANDWEIN. Harcourt, Brace & Co. New York. 1955. Pp. 107. $2.00.

This book performs an important service in presenting the most complete and scientific account of the problem of identifying, selecting and guiding the gifted student with scientific talent and interests.

Professor Brandwein, a biology teacher and chairman of the Science Department of the Forrest Hills High School of New York City, first examines the problem of identifying those who show promise of scientific achievement. In the analysis of this task he considers three factors: a Genetic (general intelligence, numerical ability, and verbal ability; a Predisposing (persistent psychological factors such as willingness to spend extra hours and labor on science work, and dissatisfaction with things as they are); and an Activating Factor based on the opportunities offered by school programs in science and skillful teaching. In applying this last or Activating Factor the author found experimentally that "it is not necessary for a teacher to depend on tests . . . If qualified teachers were to furnish sufficient opportunities in science to all students, those with high level abilities in science would come forth and identify themselves." This finding suggests that the key to the solution of the critical problem of supplying the nation with a sufficient number of future scientists rests in great measure on the shoulders of the country's science teachers.

However, in studying intelligence as one of the Genetic Factors, Brandwein finds that certain tests such as: Henmon-Nelson, Nelson-Denny, Primary Mental Abilities and the Westinghouse National Science Talent Search Examination are reliable indicators of science potential. Also studied was the determination of work habits and certain behaviors as indicators of science talent. Behavior pictures were sketched by observing such things as: how early do youngsters assume responsibility in the laboratory, what is their planning ability, to what extent do they assume leadership responsibilities, as well as an examination of their attendance records, personality traits and ways and habits of working. An experimental group of 62 was compared with a control group of the same number in order to show the operation of the behaviors that expressed the science potential.

In coming to grips with the problem of who can teach the gifted in science, the author finds that such students need gifted and intelligent teachers, high in precisely the same factors that characterize the gifted and superior students. The need for such teachers, and above all, the need for successfully overcoming the difficulties of competing with industry for their services is pointed up.

The book concludes with a list of proposals for dealing with the various facets of the problem organized at both the local and national levels. These proposals are well supported by the experimental evidence and analysis in the body of the work. Most important, they offer timely suggestions for the solution of one of the most critical of current educational problems, viz: the identification, selection, and teaching of the superior and gifted in science. These people constitute one of the world's greatest natural resources, for they and they alone have the unique potential for conceiving new theories, ideas, and processes.

Francis X. Kleyle, Ph.D.
School of Education
Duquesne University

Experimental Psychology, A Series of Broadcast Talks

• *Edited by* B. A. FARRELL. New York: The Philosophical Library. 1955. Pp. 66. $2.75.

In this series of six British radio talks describing the methods employed by experimental psychologists, the authors indicate some of the results achieved by their researches. Besides confirming by physical demonstration psychological laws already long established, the empiricists have shown how groundless were the pretensions of the pseudo-psychologist whose errors have obscured the study of human nature.

They point out that experimental psychology gives no support to: (1) the mechanistic view according to which man would be a robot, a machine ingeniously constructed to give appropriate response to stimuli; (2) the attempt to "physiologize psychology" making it a section of neurology; (3) the futile efforts of the Behaviorists to build a science of psychology by piecing together fragments of human conduct while ignoring mental phenomena which characterize sentient life; (4) the gratuitous assumptions and wild errors of the freudian Psychoanalists on Infantile Sexuality, Oedipus Complex, Castration Complex, etc.

Besides these contributions to psychology as a science, the Experimentalists can claim credit for devising a new technique in the art of Applied Psychology, by means of which the scientific knowledge acquired throughout the centuries can be utilized in solving some of the practical problems of human life—as for example the psychological tests which help to determine the abilities and aptitudes of individuals and their suitability for special types of work. These tests are as useful to the practicing psychologist as are the thermometer, X-ray and blood tests to the medical doctor. Their value is enhanced by the fact that they can be used by technicians who need not have a deep knowledge of Psychology.

Herbert Farrell, C.S.Sp.
Department of Psychology
Duquesne University

An Introduction to the Science of Metaphysics

• *By* HENRY J. KOREN, C.S.SP. St. Louis: B. Herder Book Co. 1955. Pp. XIX — 291. $4.50.

Fr. Koren has given the beginning student in Philosophy a synthetic view of some of the fundamental doctrines of St. Thomas as they have been interpreted by scholastics both old and modern, adding to these his personal interpretations and insights. He manifests great familiarity with St. Thomas. His work is remarkable especially for its order and clarity. Many classifications are given, thus enabling the student to get an over-all picture of the complex nature of the real.

In the Introduction we find a brief treatment of the levels of abstraction. A novel interpretation of St. Thomas is given, one first proposed by A. Van Melsen in *The Philosophy of Nature.* Metaphysics is defined and divided in agreement with modern scholastic tradition. The text is divided into two parts: the Philosophy of being in general and the Philosophy of finite being. In each chapter brief historical notes are given and a clear summary which is of great value for study. At the end of each chapter there is a well-chosen list of suggested readings in English.

This text is a good introduction to general metaphysics and is especially adapted to beginners.

John R. Kanda, C.S.Sp.
Department of Philosophy
Duquesne University

More Modern Wonders and How They Work

• *By* CAPTAIN BURR W. LEYSON. Second Edition. New York: E. P. Dutton and Co., Inc. 1955. Pp. 215. $3.50.

The Miracle of Light and Power

• *By* CAPTAIN BURR W. LEYSON. New York: E. P. Dutton and Co., Inc. 1955. Pp. 186. $3.50.

Captain Leyson has the ability to explain a complex subject in a language that is technically correct but at the same time comprehensible to the layman. High school students who read his books will enjoy and understand them. Their teachers should read them to improve their ability to present difficult matter in the classroom.

In "More Modern Wonders and How They Work" weapons and their ammunition, locks, the atomic submarine *Nautilus*, television, automobile, hydraulic transmissions, weather instruments and the phonograph are explained.

In "The Miracle of Light and Power" the author treats the production of electricity, gas and steam for home and industry. The production of electricity and the problems related to its distribution, maintenance and service make surprisingly interesting reading.

The chapter on electricity and safety in the home is especially valuable. It discusses the dangers of inadequate wiring, the function of the fuse, the power requirements of various appliances, and the danger signals which indicate overloaded wires. It does not attempt to scare the reader but presents a factual explanation of certain dangers and the methods of removing them.

J. P. M.

Science Laboratory

(Continued from Page 127)

tice in social living, problem solving under the drive of individual initiative, and the acceptance of responsibility.

A major achievement in the new science room arrangement is to have placed the teacher naturally at the center of the activity, with minimum radial access to all student laboratory work stations. It is possible to attain a maximum radial distance no greater than 16 feet to reach every work station in a laboratory accommodating 32 students. This is in contrast to the traditionally common practice of massing rows of tables and students in the center of the room and making it necessary for the teacher to range around the perimeter of this dense quadrangle of activity at any time easily 50 feet from some stations; finding his way with difficulty between the rows to give emergency help or to do the ordinary requirements of supervision.

With the new design in tables, students have less restricted work areas; all stations are easily accessible; access and traffic lanes make student traffic within the room frictionless; and the distances between terminal points of necessary traffic are kept to a minimum.

We sincerely believe that with modern science room planning:

(1) The teacher will be relieved of the major equipment transportation problem by storage at the point of use.

(2) The teacher's problem of equipment and inventory control will be greatly eased by organized storage planning.

(3) The students will enjoy further educational advantages in total responsibility, the habits and skills of complete control of equipment from storage to use and back to storage.

(4) Teachers and students will profit by the greater variety of activity possible.

(5) Teacher and students will be saved the time and energy consumed by needless steps and traffic friction.

(6) Teachers and students will profit by the new ease of teacher supervision.

We sincerely believe that the desirable features of the total experience idea are humanly and practically possible. They may bring new hope to those of our teachers now in despair, and perhaps may bring new recruits (to whom the odds against success were once too great) to the ranks in this time of desperate need for science teachers. ●

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Steeplechase?

"In some progressive schools all tests have been abolished. This might look like a solution, were it not that examinations are a necessary and important part of instruction. In saying this I am not arguing from the practical need to give students marks. I refer to the student's need to learn how to jump hurdles. When I say this to a class that has just groaned and stamped its feet at the announcement of a test, there usually arises a spokesman of the Shattered Nerve brigade. He offers to tell me all I want to know, if only it can be done orally and not on paper. I accept and usually find that my bodily presence does not help him organize his knowledge, whatever the effect may be on his nerve. The fact is that the examination-shy are like fence-shy horses: they have been trained badly or not at all."

—Jacques Barzun
"Teacher in America"

Silver Springs

(Continued from Page 130)

the precipitation of calcium carbonate. The oxygen was still high. In spite of extremely alkaline conditions, characteristic of pools in the desert, 4 of the aquaria still had healthy biota. An examination of plant/animal ratios showed surprising changes. The wet ratios were all about the same, (32/1, 32/1, 23/1, 29/1). Thus the readjustments due to births and deaths of snails and the growth and death of plants had modified the initially different ratios so that they were now similar. It is possible that mechanisms exist by which aquaria left to themselves can, under some conditions, readjust their own plant to animal ratios so that the amounts of plants are adequate to support the population of animals.

Whereas Atz emphasized the usual case where aquaria were not balanced because they had an excess of respiration over photosynthesis, these last experiments are an example of imbalance with an excess of photosynthesis over respiration. There was more than enough light to support the community with respect to oxygen and food supply but a developing shortage of carbon dioxide. It is not inconceivable that some intermediate conditions can be found where a balance can be obtained.

More such aquarium experiments are needed to learn how such ecological systems work. Teachers and students should write up their experiments and get them published in various magazines and bulletins.

Under some constant conditions, therefore, steady state communities may develop in nature as in the giant flowing aquarium in natural Silver Springs, Florida. The Silver Springs case and the experiments with aquaria suggest that the idea of the balanced aquarium has not been disproved. Although it is true that most aquaria are not set up with adequate light and allowed to develop a balance, there is no evidence that it can't be done. The minimum sized ecological system that can be balanced has not yet been determined.

The studies on Silver Springs were aided by a contract between the Office of Naval Research and the University of Florida NR 163-106. The aquarium experiments by Mr. Johnson were carried out as part of a course in Limnology at Duke University. ●

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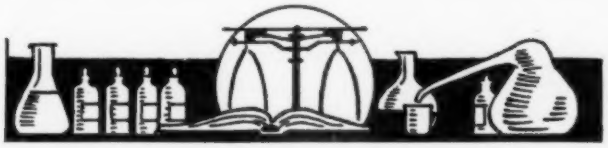

Iowa Breakfast Studies

(Continued from Page 143)

mental effect both on the attitude and scholastic attainment of the boys who followed this practice during the time they were in school.

The subjects showed no significant change in body weight whether they ate no breakfast or a basic cereal breakfast, so long as their total caloric intake per day was not changed.

The conclusions drawn from the study of boys 12-14 years of age not only confirmed many of the findings which applied to young women and young and old men, but also demonstrated that, for the most part, the good breakfast habit is a sound nutritional principle that applies to teen-agers and the young and old alike[4]. ●

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Atoms, Food and People

Atomic energy can be harnessed to the all-important task of increasing food production to meet the needs of the world's ever-growing population. This was outlined recently at Geneva in a report presented to the Atoms-for-Peace Conference by FAO expert Dr. R. A. Silow.

The three principal ways of increasing food production are by preventing loss and wastage of agricultural produce, raising the present yields by new techniques, and developing unproductive lands. Dr. Silow stressed that the applications of atomic energy have an important part to play in each of these fields. Radioisotopes, for instance, are helping scientists to learn new facts about the parasites and diseases which attack plants and cattle, while atomic radiations are being used to sterilize food stocks which can thus be stored for much longer periods.

The use of "tracers" has enabled scientists to study the fundamental processes of animal and plant physiology and thus to increase production, while experiments with plants subjected to atomic irradiation have resulted in the production of more resistant and productive strains. Further research in the fields of hydrology and pedology should make it possible to develop hitherto unproductive land.

Dr. Silow also indicated that radioisotopes were being used to study fisheries. At present fish represent only 2% of the world's food supplies, but their high protein content would make them an invaluable addition to the diet of countries where meat and other protein foods are scarce.

UNESCO

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Are You Entering A Science Fair?

Science Service announces the publication of SCIENCE EXHIBITS, by Helen Miles Davis, Editor of CHEMISTRY magazine. It is written for young scientists and teachers who are planning participation in science fairs.

SCIENCE EXHIBITS tells you how to select your material, how to plan its presentation, how to display, to label and to light it, how to describe the work you have done, how to tell about it so that those who think science is "too difficult" will understand and share your enthusiasm.

SCIENCE EXHIBITS contains samples of research project reports of the Science Talent Searches conducted annually by Science Service for the Westinghouse Science Scholarships. These reports have been selected by the Science Talent Search judging staff as outstanding for subject and method of presentation.

SCIENCE EXHIBITS describes the Science Youth Movement carried on by Science Clubs of America. This organization comprising more than 15,000 Science Clubs in the high schools of the country, encourages young people's enjoyment of doing science projects, culminating in the local and National Science Fairs. This organization is doing something to ameliorate the shortage of young scientists, technicians and engineers.

SCIENCE EXHIBITS (Cloth Bound 100 pages) price $2.00. Science Service, 1719 N Street N.W., Washington 6, D. C.

★ ★ ★ ★ ★

A handbook describing the world's weights and measures has been published by the UN Food and Agricultural Organization. Detailed information on each country's systems and units of measure is given as well as tables of equivalents and conversion factors.

★ ★ ★ ★ ★

"The net result is that quantum physics has nothing to do with the free-will problem. If there is such a problem it is not furthered a whit by the latest development in physics."

—EDWIN SCHRODINGER

Industrial Hygiene

(Continued from Page 135)

action add up to many millions of dollars, a fact which emphasizes the magnitude of the unresolved noise problem. The stress arising from improper balance between human capabilities and limitations and the demands of industrial machines represents another type of problem of concern to many workers in industry. Extensive wartime research brought into vivid focus the realization that man-machine systems built without cognizance of the human factor could not be operated optimally, or, in some cases, could not be operated at all. Remarkable parallels in the industrial environment assure a fertile field for industrial hygienists interested in these man-environment relationships. Human problems resulting from loss of job satisfaction following technological advances in production engineering represent still another area in which the intellectual teamwork characteristic of industrial hygiene is required for adequate solution. The advent of the atomic age has suddenly confronted industry with a new kind of stress, that of electromagnetic radiation. These problems are so specialized and so diverse that a new branch of industrial hygiene, called Health Physics, has evolved to deal with them. Finally, a new vista for the industrial hygienist is opened by the problems of proper selection and placement of the worker so that maximum productivity may be assured with a minimum of physiological and psychological stress. This calls for systematic stress analysis of the job and comparison with the human capabilities and limitations in relation to these same stresses—a purpose well within the scope of industrial hygiene.

But the future of industrial hygiene is broader than the mere correction of negative situations represented by hazardous conditions of work. Rather, the challenge is to create optimum conditions of work which increase the well-being of the worker and take fullest advantage of his possibilities. This, I submit, can be accomplished only by maximizing teamwork among the social sciences, psychology and sociology, the biological sciences of medicine and physiology and the physical sciences and engineering. Industrial hygiene can afford such a climate. ●

★ ★ ★ ★ ★

Verbs of teaching govern two accusatives, the person taught and the thing taught. Now obviously a great deal of our philosophy of education depends upon our view of the person taught, in other words, upon the nature of man. Obviously, those who hold that the child is composed of a material body and an immortal soul will differ *toto coelo* from those who hold that the educand is merely a machine or a physico-chemical combination, or a bundle of S-R bonds or a product of the cosmic evolutionary process. That is the reason why we have *philosophies* of education, not a philosophy of education.

—WILLIAM J. MCGUCKEN, S.J.
"The Philosophy of Catholic Education"

Sir J. J. Thomson, also, has called attention to the advantage of interrupting one's serious studies, and occupying the mind with other matters. He, too, states that the best ideas come when one is not thinking deliberately about the subject of one's study, though he takes it for granted that much and close attention has been given to it. He illustrates what he supposes to take place by comparing one's ordinary "current of thought" to an electric current. So long as the electric current continues to flow uniformly there is no induced current, whether it be self-induced or other. But if the current is suddenly stopped, there is at once a self-induced current, manifested by an electric spark at the break. He suggested that something of the same kind happens in the brain. It would, I suppose, be an interruption of the unconscious current of thought which would give rise to the sudden flash. It is interesting to note that the potential of the self-induced current is higher than that of the continuous one; in the same way the sudden flash illuminating the intellect is more powerful than the ordinary mental effort.

HENRY V. GILL, S.J.,
"Fact and Fiction in Modern Science"

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It has been estimated that a square mile of dense hardwood forest may use a million tons of water in a season.

Instead of Blackouts

Many of us are beginning to learn the word Conelrad, a plan to scramble AM radio signals so that enemy aircraft cannot use them for navigation purposes; now a new word is being added to our vocabularies. This word is CONILLUM, meaning a control of the glow over large cities, which could also be a navigation aid to enemy air crews.

The plan for CONILLUM, or illumination control, has been announced jointly by the Department of Defense and the Federal Civil Defense Administration. Its objective is twofold:

1) To reduce by about 75% "sky glow," that tower-like shaft of light reflected from the normal lighting pattern of a modern city, which is visible at high altitudes;

2) To reduce lighting in specified areas along the coasts to minimize the danger of silhouetting vessels against the coastal lights.

This plan is not a replacement of the old World War II blackout system, but is designed to eliminate the need for complete blackouts.

Secretary of Defense Charles E. Wilson, commenting on the program, said that such a plan is a military defense requirement, and said that its success is dependent on "the effective cooperation of the public, industry, and Government."

Sky Glow Control normally will be confined to areas designated by the Secretary of Defense. Farms and small villages and other communities distant from heavily-populated cities would be exempt from the requirements. However, in cities, certain commercial, industrial, and municipal preparations will have to be made. Outdoor advertising lights and exterior floodlights which contribute to sky glow would be restricted. Street lights would be shielded to reduce upward light. Within the designated areas, motor vehicles would be permitted to use parking lights only on well-lighted roadways, and only lowered headlight beams would be permitted on poorly lighted roadways.

In residential buildings, including apartment houses and hotels, ordinary window coverings such as window shades, venetian blinds or drapes would be lowered far enough to prevent a direct light from shining out above the horizontal, but the oldtime blackout curtains will not be necessary.

The plan will not go into effect immediately, but when ordered by the President or by the Commander of the U. S. Defense Command, presumably on a yellow warning.

The reason complete blackout is no longer necessary is that pilots no longer depend entirely on being able to see their target visually in order to bomb them. Instruments can guide modern bombers to their destination with reasonable accuracy even on the darkest night—though an enemy would use a visual check on his readings if it were available. The two major aids to check these readings are radio emissions from AM radio stations, and sky glow. ●

—From The Keystone Defender

Chemurgy—Living Memorial to Its Founder

When industry transforms farm and forest products into new and improved items for our use, it is following a trail blazed by Dr. William J. Hale who recently died in Midland, Michigan. It was Dr. Hale who named this science of chemurgy and was its principal promoter.

Coined from the Greek words *chemeia* meaning chemistry and *ergon* meaning work, the word "chemurgy" designates that branch of applied chemistry devoted to industrial utilization of organic raw materials, especially from farm and forest products. It has meant far reaching extension of our material resources, many of which might otherwise be discarded. The chemical industry, one of the principal beneficiaries of the relatively new science, annually transforms more than $1 billion in agricultural products into economic assets.

Some Leading Products

Best known and largest used chemurgic product is cellulose, made from wood pulp or cotton linters, and an essential constituent of such important products as cellulosic fibers and cellophane. Other chemicals of farm and forest origin include:

. . . **sorbitol,** made by hydrogenation of corn sugar and used to control moisture in products ranging from tobacco to cosmetics, and as a starting material for emulsifiers used, for instance, in food processing.

. . . **dicoumarin,** from spoiled sweet clover and hay, and used in making warfarin, rat poison, also as anticoagulant in thrombosis.

. . . **furfural,** from sugar cane waste, oat hulls and corn cobs, and used to make nylon.

. . . **activated carbon,** from wood pulp and cottonseed hulls, and used for purification of products like sugar, oils, alcohol, pharmaceuticals.

. . . **zein,** from corn, and used to make textile fiber.

. . . **lecithin,** from soy beans, and used in candy manufacture.

Newer Developments

Recent chemurgic progress has included developments in health-giving drugs:

. . . **Sitosterol** gives promise as a safe remedy for heart trouble and high blood pressure. Discovery that it can be extracted from the residue of wood used to make kraft paper sacks indicates the supply problem can be solved.

. . . **Reserpine,** from tropical and semi-tropical Rauwolfia plants, is widely used in treating mental diseases and hypertension. New production techniques, based on ultraviolet absorption, paper chromatography and fluorescence, are expected to facilitate production.

. . . **Rhododendron** and periwinkle contain chemical compounds helpful in combatting high blood pressure.

. . . **Radioactive ergot** now makes possible research with this parasitic fungus from which muscle contracting drugs are extracted.

. . . **A cheap and easy-to-use acid** made from orange and lemon pectin, gives promise of decreasing the reactions from toxic drugs when the pectin is chemically combined with them.

From Sugar and Wood

Fermentation of agricultural products produces other chemical products. For example, itaconic acid, made by fermenting molasses, is considered the prize product of sugar chemistry. A versatile building block for other chemicals, with particular promise in the manufacture of resins, plastics and synthetic fibers, it is now available in carload quantities.

Also, fermentation-produced citric acid of high stability is a potentially useful intermediate in the production of pharmaceutical compounds.

New products likewise are being developed from wood wastes. Chemicals from lignin, which constitutes 20 to 30 per cent of wood and which until recently was discarded in manufacturing, are being used in controlling the fluidity of oil well drilling muds, in lowering water requirements in the manufacture of gypsum board, in preventing scale in boiler tubes, in making synthetic rubber for tire treads and in dye dispersants for synthetic fibers.

From tree bark, another wood waste, a new wax has just been made. Out of 35 pounds of the bark of Ponderosa pine—one pound of the new product is produced. Also, a new soil conditioner made of chemically processed redwood bark has just gone on the market.

Extensive research is currently being directed toward obtaining new chemical products from sugar. One is a pesticide; another is a detergent.

Chemurgy's Future

Advances in this science and its application to meet man's increasing needs are continuing proof of the genius and foresight of chemurgy's dynamic apostle, Dr. Hall.

None has contributed more to the rise of the chemical industry to a major role in America's economy today.

From "Chemical News"

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Southeastern Conference

(Continued from Page 140)

recent scientific developments in the area, as well as the experiences and methods by which the content area may be transmitted to students. ●

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[2] This article was written before the Michigan Conference, which was held as planned. The report of the 1955 conference will be printed as a special issue of *The American Biology Teacher.*

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Articles are listed under the author's name. Book reviews under the name of the author of the book. (R) indicates a book review. The name of the reviewer follows in parenthesis.